

Mercury in the Sky With Diamonds | This Fabric Is All Ears

ScienceNews

MAGAZINE OF THE SOCIETY FOR SCIENCE ■ APRIL 9, 2022

Fuzzy Feelings

How do we know if an animal is content, angry or bored?



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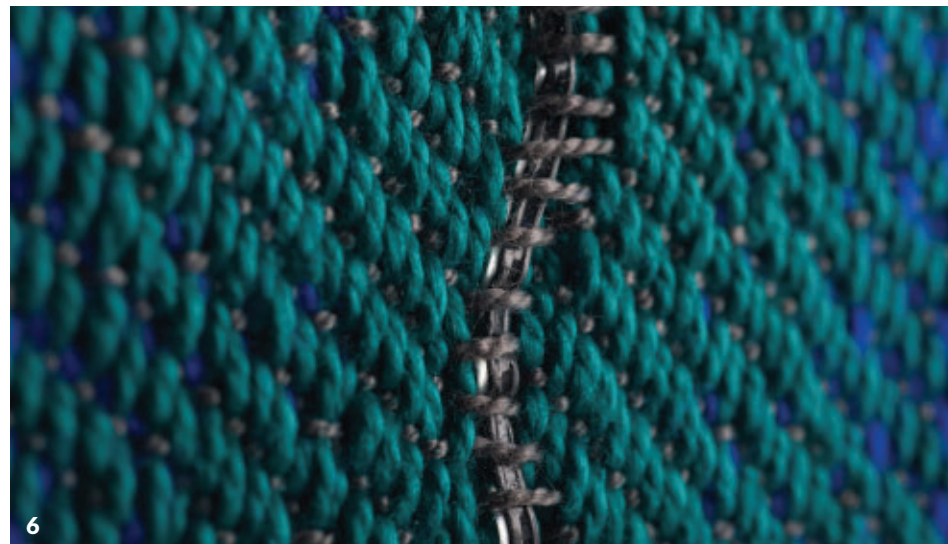


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COVER People often misjudge cues about animal emotions, though these two dogs sure look happy. *Ilka & Franz/Stone/Getty Images*

FROM TOP: INSTAGRAM: @SUNFLORADESUI; ANDREAS KAY/FILICKR (CC BY-NC-SA 2.0); FINK LAB/MIT; ELIZABETH MEIKLE/JOHN/RISE; GREG HREN



In Pandemic Year Three, still so many questions

Last November, thousands of people traveled to New York City for the Anime NYC conference. It was a joyous event, and not just because attendees dressed as characters from their favorite Japanese animation series. It was also for many people the first time they had been able to gather in large groups since the start of the pandemic.

But once people were back home, that warm glow quickly wore off. News broke that one of the first people in the United States confirmed to have the highly contagious omicron variant was an Anime NYC attendee. But as we report in this issue, the precautions that event organizers and attendees took, including requiring vaccinations and wearing masks, kept the gathering of 53,000 people from becoming a superspreader event (Page 22).

We're now in the third year of the COVID-19 pandemic. And alas, we still have to ask how we can keep people safe, at a convention, in a classroom or around a poker table. The record-shattering surge in cases sparked by omicron in the United States has waned, but the BA.2 variant is now driving surges in Europe and Asia. Is another wave on the way?

Scientists are just as tired of saying "not sure" as everyone else is tired of hearing it. But it's easy to forget how much more we know now than we did in the spring of 2020. Back then, we were seeking answers to questions including "Can blood plasma from people who recovered from COVID-19 treat the sick?" and "Can fabric masks stem the coronavirus' spread?" We were even wondering if we had to disinfect the groceries.

Now we know that plasma treatments aren't much help, but research has shown that other therapies, including monoclonal antibodies and antivirals, do help fend off serious illness and death. We know that though a fabric mask is better than nothing, high-quality KF94, KN95 or N95 masks are far better at preventing spread. We know that improving ventilation indoors can reduce risk. And we know that the vaccines are a public health triumph, dramatically reducing the risk of death even from the delta and omicron variants. And booster shots help maintain that protection.

But still, so many questions. Should people still wear masks indoors, despite states dropping mask mandates? What does it mean that COVID-19 "changes" your brain? When oh when will we get vaccines for children under age 5? Do I have enough rapid tests to navigate my way through yet another wave?

And the ultimate question: When is this going to end? Unfortunately, there's no off switch for the pandemic, our staff writer Erin Garcia de Jesús (and Ph.D. virologist) wrote recently (*SN Online*: 2/24/22). But as epidemiologist Aubree Gordon of the University of Michigan in Ann Arbor told her then, even with new variants emerging to bedevil us, pandemics always end.

So the end is — maybe not near, but surely coming. I'm longing for the day when COVID-19 is not part of our breaking news lineup. Until then, we'll be working hard to cover Pandemic Year Three for you online, in the magazine and in our weekly Coronavirus Update newsletter. — Nancy Shute, *Editor in Chief*

To subscribe to Coronavirus Update, visit www.sciencenews.org/special-newsletter

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SACRED STONE OF THE SOUTHWEST IS ON THE BRINK OF EXTINCTION



Centuries ago, Persians, Tibetans and Mayans considered turquoise a gemstone of the heavens, believing the striking blue stones were sacred pieces of sky. Today, the rarest and most valuable turquoise is found in the American Southwest— but the future of the blue beauty is unclear.

On a recent trip to Tucson, we spoke with fourth generation turquoise traders who explained that less than five percent of turquoise mined worldwide can be set into jewelry and only about twenty mines in the Southwest supply gem-quality turquoise. Once a thriving industry, many Southwest mines have run dry and are now closed.

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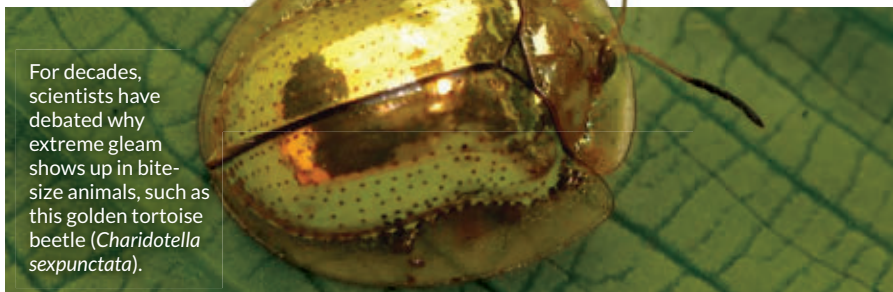
Excerpt from the April 8, 1972 issue of *Science News*

50 YEARS AGO

Farming the sun's energy

More and more scientists and engineers are beginning to believe that solar conversion will account for a significant portion of the world's future power needs.... What has changed the atmosphere lately is ... the possibility of putting together large-scale units, solar-energy "farms" that would compete with power stations in the megawatt range and higher.

UPDATE: Solar energy production in the United States ramped up as solar panels became cheaper to manufacture and more efficient at generating electricity (*SN*: 3/1/08, p. 133). Since the first U.S. solar power plant opened in 1982, thousands more have been built, bringing the country's solar capacity today to more than 100 gigawatts. In 2021, solar energy made up nearly 3 percent of the electricity produced in the United States. And the future is looking bright: Solar energy and storage is projected to account for more than 60 percent of the U.S. power grid's new generating capacity from 2022 through 2023, according to the U.S. Energy Information Administration.



For decades, scientists have debated why extreme gleam shows up in bite-size animals, such as this golden tortoise beetle (*Charidotella sexpunctata*).

THE SCIENCE LIFE

Scientists scuff a theory about shiny disguises

This is a story about camouflage, but forget mud-blob brown, mealy beige and somber green. Here scientists study mirror glitz and the paradoxical notion that there's a shiny side to camo.

Mirrorlike surfaces have evolved in open-ocean fishes, as well as in spiders, butterfly chrysalises and most branches of the vast diversity of beetles, says visual ecologist Amanda Franklin of the University of Melbourne in Australia. One popular idea proposes that these living mirrors might confound predators by reflecting water, leaves, twigs or whatever.

For a test of dry-land mirrors, Franklin and colleagues turned to a showy group of about 40 species of scarab beetles, some with a natural metallic gleam. In golds, bronzes, greens and blues, the beetles take their adult form and climb into eucalyptus trees seeking mates during their native Australia's high summer in December. "People love Christmas beetles," Franklin says.

To see if reflection provides protection, Franklin set out to create nubs of clay roughly the shape of two greenish Christmas beetles, one with a mirror finish and one matte like their real-life counterparts, *Anoplognathus parvulus* (shiny) and *A. prasinus* (dull).

Creating a "brushed-metal" look was



Visual ecologist Amanda Franklin and colleagues set out matte-finish beetle decoys (left) and shiny-mirror ones (right) in the wilds of Australia to see which looks drew hungry birds.

easy, but Franklin needed fake beetles with a mirror finish. She also needed something fast to make. "If you have to sand it all day, you're not going to be able to make a thousand," Franklin says.

But prototype after prototype failed to shine. After about six weeks, "we probably had hundreds in the throw-out bin," Franklin says. A specialist in a hobby shop where her father had for years bought supplies for making model World War II planes finally helped solve the shine problem.

The trick to beetle-grade reflectivity turned out to be finding just the right super-smooth resin to coat the models before spray-painting. To make the dull versions, a little sanding muted the mirror look appropriately.

Franklin's team then set out more than 1,000 models for four to six days in two regions of Australia. In areas where butcherbirds, cuckooshrikes and other beetle eaters hunted, the team checked for beak marks indicating bird attacks. The mirror finish didn't show a clear benefit, Franklin and colleagues reported in the January *Functional Ecology*. The bodies of the glossy fakes had just about as many gashes and dings from bird strikes as the matte models did.

A test with people as pretend predators wearing eye-trackers also failed to show that shiny things were harder to find than the scuffed, duller beetles. "The benefit is that you can tell a human what to do," Franklin says.

Mirror camo might work in some crises, but Franklin now wonders if the big advantage perhaps has little to do with looks. The complicated microstructures that create the mirrors might, for instance, reduce the danger of cracks or fungal cooties. *Homo sapiens* fixates on looks, but maybe the visual thrill of a Christmas beetle's mirror is just a holiday bonus. — Susan Milius

INTRODUCING

Invasive moth's new name replaces an ethnic slur

A menacing pest just became a bit less problematic, at least socially, after getting an update to its common name. *Lymantria dispar* is an invasive insect previously known as the gypsy moth — a label that contains an ethnic slur. On March 2, the Entomological Society of America renamed *L. dispar* the spongy moth.

The updated term is a nod to the moth's porous egg masses. The name was selected through ESA's Better Common Names Project, after hundreds of new name suggestions for *L. dispar* poured in following the retirement of the old name in July 2021. That decision is part of a growing trend to rebrand animals and plants whose names reference racial or ethnic slurs or honor white colonizers (SN: 9/25/21, p. 12).



Lymantria dispar's new common name, spongy moth, refers to the insect's porous egg masses (brown masses beneath the moths).

ESA elected the moth for a rebrand primarily due to its frequent presence in conversation. Now, entomologists and gardeners alike can discuss the pest without using pejorative language.

It's one action in a larger mission to decolonize science, which aims, in part, to create a more diverse and inclusive environment. "Decolonizing science is actually a really broad process," says Jessica Ware, ESA president and an entomologist at the American Museum of Natural History in New York City. "Addressing common names is just one piece."

ESA will continue to gather input on insect names that perpetuate stereotypes or contain insulting references, Ware says. — *Jude Coleman*

THE EVERYDAY EXPLAINED

Why raindrops on car windows slide up and down

Staring at raindrops on a car windshield is more than just a way to get in touch with your emo side. You might also learn some physics.

As a car speeds along in the rain, some water droplets slide up the windshield, others slide down, and some seem stuck in place. "It's very hypnotizing, isn't it?" says fluid mechanics researcher Sungyon Lee of the University of Minnesota in Minneapolis.

Lee and Alireza Hooshanginejad, a fluid mechanics researcher at Cornell University, used mathematical equations to describe the forces on the raindrops. That work revealed several factors that determine a droplet's behavior, the pair reports in the March *Physical Review Fluids*.

Raindrops on a moving car's angled windshield simultaneously experience forces from gravity and from the wind that speeds over the car. The direction that a raindrop moves depends on its size. For larger raindrops, gravity wins, pulling the droplets down. For smaller raindrops, wind prevails, pushing them up the slope. For medium-sized raindrops, the forces balance out and the droplets sit still. The tiniest raindrops also stay put, because the wind doesn't provide enough oomph to overcome water's tendency to adhere to the glass. Factors such as the car's speed and the windshield's steepness affect the raindrops' behavior too, the results suggest.

The scientists studied a simplified version of raindrops, so the results won't translate perfectly to real-world droplets, Lee says. But the research still gives a sense of why water droplets do what they do. — *Emily Conover*

RETHINK

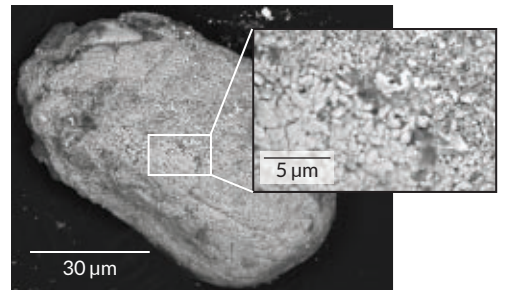
Greenland impact crater is surprisingly old

The powerful impact that created a mysterious crater at the northwestern edge of Greenland's ice sheet happened about 58 million years ago, researchers report March 9 in *Science Advances*.

That timing means the space rock that carved the crater struck long before the Younger Dryas cold snap about 13,000 years ago. Some researchers have suggested the cold spell was caused by such an impact (SN: 7/7/18, p. 18).

Scientists discovered the crater, a 31-kilometer-wide depression dubbed Hiawatha, buried beneath about a kilometer of ice in 2015 (SN: 12/8/18, p. 6). To determine how old the crater might be, geochemist Gavin Kenny of the Swedish Museum of Natural History in Stockholm and colleagues turned to sediments that had been ported out by meltwater at the ice's base. Those sediments bear telltale signs of alteration by an impact, such as sand from partially melted rocks and pebbles containing deformed zircon crystals.

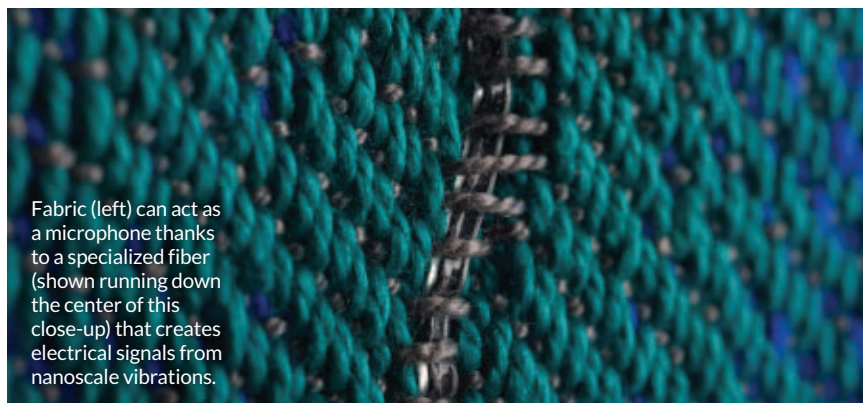
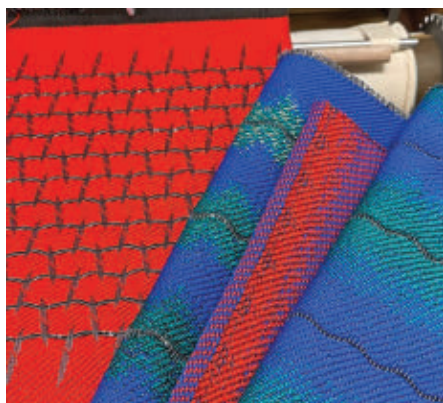
The team dated alterations in the zircons based on the radioactive decay of uranium to lead. In the sand, the team compared the abundances of radioactive forms of argon with stable forms. Both methods suggest the impact occurred 57.99 million years ago, making the crater too old to be the smoking gun long sought by proponents of the Younger Dryas impact hypothesis. What impact this space punch may have had on Earth's climate remains a mystery. — *Carolyn Gramling*



Pebbles from Greenland's Hiawatha impact crater contain grains of zircon (one shown) made of many tiny crystals, some of which were altered by the impact (inset). The crystals have helped reveal when the impact occurred.

This fabric can hear your heartbeat

Sound-sensing fibers could act as a hearing aid or health monitor



Fabric (left) can act as a microphone thanks to a specialized fiber (shown running down the center of this close-up) that creates electrical signals from nanoscale vibrations.

BY CAROLYN WILKE

Someday our clothing may eavesdrop on the soundtrack of our lives, capturing the noises around and within us.

A new fiber acts as a microphone — picking up speech, rustling leaves and chirping birds — and turns those acoustic signals into electrical ones. Woven into a fabric, the material can hear handclaps and its wearer’s heartbeat, researchers report March 16 in *Nature*. Such fabrics could provide a comfortable, nonintrusive — even fashionable — way to monitor body functions or aid with hearing.

Acoustic fabrics have existed for perhaps hundreds of years, but they’re used to dampen sound, says Wei Yan, a materials scientist at Nanyang Technological University in Singapore. Fabric as a microphone is “totally a different concept,” says Yan, who worked on the fabric while at MIT.

Yan and his colleagues were inspired by the human eardrum. Sound waves cause vibrations in the eardrum, which are converted to electrical signals by the cochlea. “It turns out that this eardrum is made of fibers,” says Yoel Fink, a materials scientist at MIT. In the eardrum’s inner layers, collagen fibers radiate from the center, while others form concentric rings. The crisscrossing fibers play a role in hearing and look similar to woven fabrics, Fink says.

Analogous to what’s happening in an eardrum, sound vibrates fabric at the

nanoscale. In the new fabric, cotton fibers and others of a somewhat stiff material called Twaron efficiently convert incoming sound to vibrations. Woven together with these threads is a single fiber that contains a blend of piezoelectric materials, which produce a voltage when pressed or bent. The buckling and bending of the piezoelectric-containing fiber creates electrical signals that can be sent through a tiny circuit board to a device that reads and records the voltage.

The fabric microphone is sensitive to a range of noise levels, from a quiet library to heavy traffic, the team reports, though the researchers are continuing to investigate what signal processing is needed to detangle target sounds from ambient noise. Integrated into clothing, this sound-sensing fabric feels like regular fabric, Yan says. And it continued to work as a microphone after 10 washings.

Piezoelectric materials have “huge potential” for applications from listening to a person’s heart, lungs and stomach to monitoring the integrity of aircraft materials, says Vijay Kumar Thakur, a materials scientist at Scotland’s Rural College in Edinburgh who was not part of this work. They’ve even been proposed for energy generation, but, he says, many uses have been limited by the tiny voltages they produce. The way the sound-sensing fibers are made — sandwiching a blend of piezoelectric materials between other components, including a flexible,

stretchy outer material — concentrates the energy from the vibrations into the piezoelectric layer, enhancing the signal it produces.

As a proof of concept, the team incorporated the fabric into a shirt, which could hear its wearer’s heart like a stethoscope does. Used this way, the fabric microphone could listen for heart murmurs and may someday be able to provide information similar to an echocardiogram, an ultrasound of the heart, Thakur says. If proved effective as monitoring and diagnostic tools, fabric microphones placed into clothing may someday make it easier for doctors to track heart conditions in young children, who have trouble keeping still, he says.

The team anticipates that fabric microphones could aid hearing and communication. Another shirt that the researchers created had two piezoelectric fibers spaced apart on the shirt’s back. Based on when each fiber picked up the sound, this shirt can be used to detect the direction a clap came from. And when hooked up to a power source, the fabric microphones can project sound as a speaker.

“For the past 20 years, we’ve been trying to introduce a new way of thinking about fabrics,” Fink says. Beyond providing beauty and warmth, fabrics may help solve technological problems. And perhaps, Fink says, they can beautify technology too. ■

Lithium mining puts flamingos at risk

Quest for 'greener' tech guzzles up water in Chile's salt flats

BY JAKE BUEHLER

Flamingos may be a kind of canary in the coal mine when it comes to warning that there can be hidden costs of green technologies. Lithium mining appears to be a major threat to the iconic pink birds that rely on salt flats bordering the high Andes. Mining of the metal and climate change together are causing the decline of two flamingo species found only on Andean plateaus, researchers report in the March 9 *Proceedings of the Royal Society B*.

Because of its use in lightweight, rechargeable batteries for electric cars, smartphones and other items, lithium is expected to play a major role in helping fight climate change. And global demand is expected to soar (SN: 5/11/19 & 5/25/19, p. 40). The new finding fits into a growing body of research revealing lithium mining's adverse impacts on ecosystems.

One of the world's richest deposits of lithium spans parts of Chile, Bolivia and Argentina, an area dubbed the "lithium triangle." The region is also home to the Atacama Desert and a series of shallow, salt flat lake ecosystems, known as salars, that depend on the area's limited water supply. These ecologically sensitive salars

nourish the cyanobacteria and algae eaten by three types of flamingos, half of the world's flamingo species.

This ecosystem is in an existential conflict because lithium refinement ponds and other industrial mining processes use a vast amount of water — an estimated 400,000 liters per ton of lithium, says Nathan Senner, a population ecologist at the University of South Carolina in Columbia. There's only so much water to go around. "This is literally the driest desert in the world," he says.

Senner — with ecologist Jorge Gutiérrez of the University of Extremadura in Spain, bird ecologist Juan Navedo of the Austral University of Chile in Valdivia and others — gathered over 30 years' worth of flamingo surveys. The team also tracked water surface area changes and cyanobacteria levels in five salars by looking at satellite images and considering climatic factors, such as precipitation and temperature, that can influence water levels.

Since 1984, the five salars have shrunk by more than 30 percent in surface area, the researchers found. The decline is partially due to increased evaporation, which is influenced by climatic factors. Water levels also varied greatly across years.

Those fluctuations appear to strongly dictate the number of flamingos present in a given year by determining the availability of food. Flamingo counts "can change by literally thousands of individuals across just a couple of years," Senner says.

The long-term drying trend caused by climate change is being exacerbated by ever-thirsty lithium mining, the team concludes. And the mining is leaving a mark on two of the flamingo species: the Andean (*Phoenicoparrus andinus*) and the James' (*P. jamesi*) flamingos, whose populations declined between 10 and 12 percent over 11 years, from 2002 to 2013, in Chile's Salar de Atacama. This equals a loss of hundreds of birds.

The team ties the decline to lithium mining. As mining ponds in the salar grew, nearby James' and Andean flamingo populations dwindled. Water loss from new mining activity may be a major culprit. Between 1986 and 2018, groundwater pumping for lithium production increased from zero to an average rate of 1.8 cubic meters per second, and the salar lost about five football fields' worth of surface water area every winter.

Flamingo declines and salar drying could have reverberating effects on people since flamingo-based ecotourism in the region could suffer, the team says.

"Science-based conservation management guidelines might still allow future preservation of some key hypersaline systems in the region," says Mattia Saccò, an ecologist at Curtin University in Perth, Australia.

As the need for lithium rises, the threat to flamingos may only increase. "It's a real conundrum because obviously no one is going to argue that climate change is not this monster that we need to contend with," Senner says. But being aware of the consequences of potential climate change solutions is crucial to weighing the costs and benefits of those options, he says.

In the case of lithium, finding ways to reduce the ecological costs could be one way forward, Senner says, such as by making mining more water efficient or improving the ability to recycle lithium from used batteries. ■



Flamingos feed in Salar de Atacama in Chile. Local populations of these water birds may dwindle as lithium mining and climate change dry out lakes in this region of South America.

ATOM & COSMOS

Glimpse of cosmic dawn doubted

Astronomers may not have found a sign of the first stars after all

BY EMILY CONOVER

A new study casts a haze over a hint of the universe's first glimmers of starlight.

In 2018, researchers claimed that a subtle signature in radio waves from early in the universe's history had revealed the era when the first stars switched on, known as the cosmic dawn. But the first experiment to test that study's conclusions found no sign of those early stars, scientists report February 28 in *Nature Astronomy*.

Just after the Big Bang about 13.8 billion years ago, the universe was a hot stew of matter. Stars probably didn't flicker on until at least 100 million years later — a poorly understood era of the cosmos. Finding signs of the first beams of starlight would flesh out the cosmic origin

story. So the 2018 claim that the EDGES experiment in Australia had pinpointed those earliest gleams caused an astronomical hubbub (SN: 3/31/18, p. 6).

"It definitely completely excited our whole community with this fascinating result," says radio astronomer Saurabh Singh of the Raman Research Institute in Bangalore, India.

The EDGES researchers reported detecting a dip across particular wavelengths of radio waves, a sign of light from the first stars interacting with surrounding hydrogen gas. But the result quickly raised doubts because the dip was deeper than expected. To know whether the hint of the first starlight was real, scientists would need to make more measurements.

Singh and colleagues did just that with the Shaped Antenna Measurement of the Background Radio Spectrum 3, or SARAS 3. Like EDGES, the experiment uses an antenna to pick up radio waves. But SARAS 3 has a different design, with a differently shaped antenna. And SARAS 3 floats atop a lake. "That gives us a very distinctive advantage," Singh says.

On Earth, radio waves come from a variety of sources, which must be carefully accounted for to reveal the subtler signal from the cosmic dawn. Misunderstanding those other sources of radio waves could lead to an unaccounted-for experimental error that might give incorrect results.

In particular, experiments on land must contend with radio waves emitted from the ground, which are difficult to estimate due to the complex, layered nature of soil. When the antenna is atop a lake, it's easier to estimate what kinds of radio waves come from the uniform water

ATOM & COSMOS

Nearby 'black hole' fooled scientists

Contested star system reveals new stage of stellar pairings

BY LIZ KRUESI

The nearest black hole to Earth isn't a black hole at all. Instead, what scientists thought was a stellar triplet — two stars and a black hole — is actually a pair of stars caught in a unique stage of evolution.

In 2020, astronomers reported that the star system HR 6819 was probably made up of a bright blue, massive star locked in a tight orbit with a nonfeeding black hole plus a second blue star orbiting the pair farther away. At about 1,000 light-years from Earth, this black hole would be the nearest one to us (SN: 6/6/20, p. 8). But other teams later analyzed the data and came to a different conclusion: The system hosts only two stars and no black hole.

Now, the original team and one of the follow-up teams have joined forces and looked at HR 6819 with more powerful telescopes that collect a different type

of data. The new data record finer details on the sky, allowing the astronomers to definitively learn how many objects are in the system and what types of objects they are, the teams report in the *March Astronomy & Astrophysics*. "Ultimately, it was the binary system that best explains everything," says astronomer Abigail Frost of KU Leuven in Belgium.

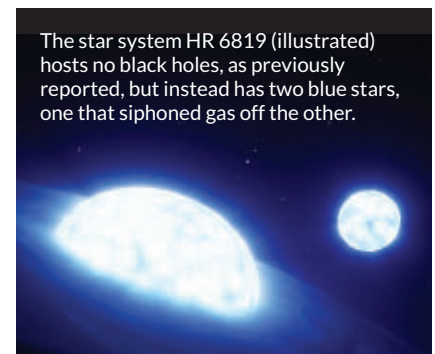
Previous observations of HR 6819 showed it as a unit, so astronomers could only go by the color and brightness of the objects in the system, and two very different alternative explanations fit the available data. To nail down HR 6819's true nature, Frost and colleagues turned to the Very Large Telescope, a network of several interconnected telescopes in Chile that can essentially see the separate stars.

"It allowed us to disentangle that original signal definitively, which is really important to determine how many stars were in it, and whether one of them was a black hole," Frost says.

The scientists think one of the stars is a massive bright blue star that had been siphoning material from its orbiting companion star's bloated atmosphere. That companion star now has little gaseous

atmosphere left. "It's already gone through its main life, but because the outside has been stripped off, and you only see the exposed core, it has similar temperature and luminosity and radius to a young star," says Kareem El-Badry, an astrophysicist at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass. El-Badry, who wasn't involved in the new study, suggested in 2021 that HR 6819 is a binary system.

The blue color and brightness of that siphoned star's core could fool astronomers looking at the older data into thinking it was a young star with far more mass. And in this scenario, it appeared as though this star was orbiting something



The star system HR 6819 (illustrated) hosts no black holes, as previously reported, but instead has two blue stars, one that siphoned gas off the other.

below. Data taken from two lakes in India revealed no sign of the dip.

The new study “highlights just how difficult this measurement is,” says physicist H. Cynthia Chiang of McGill University in Montreal. It’s uncomfortable that the two studies disagree, she says, but the disagreement “isn’t quite enough to make any definitive conclusions at this point.”

Some of the same types of experimental issues that may affect EDGES could also affect SARAS 3, says experimental cosmologist Judd Bowman of Arizona State University in Tempe, a member of the EDGES team. “We still have more work ahead to reach the final outcome.”

An improved version of EDGES will be deployed later this year, and the SARAS 3 team has additional deployments planned. Other experiments are also working on similar measurements. Those tests may finally illuminate the universe’s transition from darkness to light. ■


massive but invisible — a black hole.

Once the researchers unraveled the details, they realized the system exhibits a phase not seen before among systems with massive stars. “It is a missing link in binary star evolution,” says astrophysicist Maxwell Moe of the University of Arizona in Tucson, who was also not part of the new study.

Astronomers have seen binary systems where one star is actively pulling gas off the other and systems where the donor star is just a naked core. In HR 6819, the donor star has just stopped giving mass to the other, but it still has some of its envelope left. It’s “quickly contracting, evolving to become a remnant core,” Moe says.

Frost and colleagues are using the Very Large Telescope to monitor HR 6819 over a year to track precisely how the stars are moving. The team will feed that information into simulations of binary star evolution. It’s “exciting to now have a system that we can use as kind of a cornerstone to investigate this in more detail,” Frost says.

Even though HR 6819 doesn’t have the nearest black hole to Earth, the system might have something even more useful to astronomers. ■



Coronal loops (shown) on the sun appear to be single strands of plasma. But some of these loops may be optical illusions caused by “wrinkles” in the solar atmosphere.

ATOM & COSMOS

Coronal loops aren’t what they seem

Some solar arches may be wrinkles in a veil, simulations show

BY ALLISON GASPARINI

Coronal loops, well-defined hot strands of plasma that arch out into the sun’s atmosphere, are iconic features of solar imagery. But many of these supposed coronal loops might not be there at all.

Some of these loops might be an illusion created by “wrinkles” of greater density in a curtain of plasma that researchers are dubbing the coronal veil. If true, the finding, based on computer simulations of the sun’s atmosphere and reported in the March 1 *Astrophysical Journal*, may change how scientists measure some properties of our star.

“It’s kind of inspiring to see these detailed structures [the wrinkles in the veil],” says astrophysicist Markus Aschwanden of Lockheed Martin’s Solar and Astrophysics Laboratory in Palo Alto, Calif., who wasn’t part of the study. “They are so different than what we anticipated.”

Researchers use coronal loops to measure temperature, density and other properties of the sun’s outer atmosphere, or corona, and the loops may be key to figuring out why the corona is so much hotter than the sun’s surface. But astronomers have long wondered why the loops appear to be so orderly when they originate from the sun’s turbulent surface.

Solar physicist Anna Malanushenko of the National Center for Atmospheric

Research in Boulder, Colo., and colleagues sought to isolate coronal loops in 3-D computer models developed to simulate the life cycle of a solar flare. The team expected to see neatly oriented strands of plasma because coronal loops appear to align themselves to the sun’s magnetic field, like metal shavings around a bar magnet.

Instead, the plasma appeared as a curtainlike structure winding out from the sun’s surface that folded in on itself like a wrinkled sheet. As the team changed the viewpoint in the simulation, the shape and orientation of the wrinkles changed. From certain angles, they resembled coronal loops. “The traditional thought was that if we see this arching coronal loop that there is a garden hose-like strand of plasma,” Malanushenko says. But the structure of so-called loops was more raggedy and complex, with complicated boundaries.

Still, not all coronal loops are necessarily illusions. “We don’t know which ones are real and which ones are not,” says Malanushenko. “We absolutely need to be able to tell to study the solar atmosphere.”

It’s also not clear how the purported coronal veil might impact previous solar analyses. “On one hand, this is depressing,” Malanushenko says. On the other, she says, the uncertainty is exciting. Astronomers will need to develop a way to observe the veil and confirm its existence. ■



Octopuses (purple) off California have shorter brood times than expected thanks to geothermal springs.

LIFE & EVOLUTION

Deep-sea ‘octomoms’ seek the heat

Laying eggs near geothermal springs speeds up hatching

BY KATHERINE KORNEI

Octopuses living in the deep sea off California breed far faster than expected.

The animals lay eggs near geothermal springs, and the warm water speeds up embryonic development, researchers reported February 28 at the virtual 2022 Ocean Sciences Meeting. Thanks to that trick, octopus moms brood—care for their developing eggs—for less than two years, instead of the predicted dozen-plus.

Off the coast of central California in 2018, scientists discovered thousands of deep-sea octopuses (*Muusoctopus robustus*) congregated on the seafloor about 3,200 meters below the surface. Many of the grapefruit-sized animals were females brooding eggs, leading researchers to dub the site the Octopus Garden.

With water temperatures hovering around 1.6° Celsius, growth in this garden was predicted to be leisurely. In octopuses, embryonic development tends to slow down at low temperatures, says marine ecologist Jim Barry of the Monterey Bay Aquarium Research Institute in Moss Landing, Calif. “When you get really cold, down near zero, that’s when brood periods get really long”

The record for the longest brood period of any animal, just over four years, is held by a different species of octopus living in warmer water (SN: 9/6/14, p. 5). *M. robustus* was therefore a serious contender to snatch that title, Barry says. “If you look at its predicted brood period at 1.6° C, it’s over 12 years.”

Barry and colleagues repeatedly visited the Octopus Garden from 2019 to 2021 using a remotely operated vehicle. The team trained cameras on the eggs, which resemble white fingers, to monitor their rate of development. Using one of the submersible’s robotic arms, the team also gently nudged dozens of octopuses aside to measure water temperature in nests.

Relatively warm water, up to 10.5° C, bathed the egg clutches. Females preferentially lay eggs in streams of geothermally heated water, which is much warmer than the ambient water, the team realized. That discovery was a tip-off that these animals are not long-haul moms. “We’re virtually certain these animals are breeding far more rapidly than you’d expect,” Barry says. His team estimates that moms brood for only about a year and a half.

There’s an evolutionary advantage to octopus moms seeking out warmer water: Shorter brood periods mean fewer eggs are likely to be gobbled up by predators. “We believe they’re exploiting that thermal energy to improve reproductive success,” Barry says.

Only a few marine animals, such as Antarctic icefish, are known to preferentially breed in warmer waters. But other species probably do the same, says Jeffrey Drazen, a deep-sea ecologist at the University of Hawaii at Manoa. The challenge is finding them in the deep ocean. “I imagine that as we keep looking, we will keep finding really interesting sites that are important to certain species,” he says. ■

LIFE & EVOLUTION

Cephalopod fossil stirs up debate

Find could revise family tree of octopuses and vampire squid

BY ANNA GIBBS

A cephalopod fossil may rewrite the history of octopuses and vampire squid, but it depends on who you ask. At the very least, the debate offers a lesson in how hard it can be to classify fossils.

Because cephalopod bodies decay easily, it’s rare to find well-preserved fossils of this group, which includes octopus, squid and cuttlefish. The slim pickings have made establishing the animals’ family tree a headache for paleontologists.

Enter a roughly 330-million-year-old fossil from Montana with exquisitely preserved suckers and 10 arms. A close look suggests that it’s a type of cephalopod called a vampyropod, a group that includes octopuses and vampire squid, researchers argue March 8 in *Nature Communications*.

If true, that would make this animal the oldest known vampyropod by about 80 million years. It would also suggest that a defining feature of this group evolved much more quickly than previously thought. “This is overturning about 100 years of science in cephalopod evolution,” says Christopher Whalen, an invertebrate paleontologist at the American Museum of Natural History in New York City.

But not everyone is convinced. The classification hinges on the fossil having a gladius, a hard internal body part shaped like a Roman sword of the same name. In this specimen, the gladius can be identified by slender growth lines along the fossil’s edge, as well as a rib running down the fossil’s center, Whalen says.

But where he and his museum colleague Neil Landman, also a paleontologist, see a gladius, others see something else.

“That’s not a gladius, I’m sorry,” says Christian Klug, a cephalopod paleontologist at the University of Zurich. He argues that the feature is actually a flattened conical tube containing a phragmocone, the series of chambers found in the shells of

early cephalopods. If there's no gladius, the fossil wouldn't be a vampyropod after all.

Different interpretations of fossils are not uncommon. A famous example is *Tullimonstrum*, aka the Tully monster, discovered in the 1950s. Paleontologists still disagree about whether it's a vertebrate.

"They're all looking at the same fossils and the same features," says invertebrate paleontologist Roy Plotnick of the University of Illinois Chicago. But something as simple as orientation can affect interpretation. Plotnick is working on a study about a fossil that was classified as a jellyfish for almost 50 years; upon flipping it upside down, he realized it's a sea anemone.

Identifying fossil features is much more than eyeballing. For starters, paleontologists need a deep-seated knowledge of anatomy. They also need to understand the processes of fossilization and decay. If a feature is missing, a paleontologist will consider whether it was absent in the living animal or just not preserved.

"You need to come up with a frame of reference, some sort of interpretive



How to classify this roughly 330-million-year-old cephalopod fossil hinges on whether the central portion of the fossil preserves the remains of an anatomical feature called a gladius.

framework," Whalen says. The preserved suckers allowed him to identify the fossilized animal, which he and Landman dubbed *Syllipsimopodi bideni*, as a cephalopod. "Once you've got that, then you can start to focus on interpreting the different structures under that framework."

Prioritizing one piece of evidence over another can become subjective. "Even with well-preserved species, you can get terrific differences in interpretation," says Kevin Padian, a vertebrate paleontologist at the University of California, Berkeley. Some scientists prefer not to stray from traditional means of classification. Some choose to emphasize certain parts of the

anatomy over others. Some lump specimens together into one species, whereas others will differentiate them more readily.

It might not sound like an exact science, but the addition of evidence can increase certainty. In the case of *S. bideni*, discovering more specimens could help researchers home in on the correct interpretation. Sophisticated technologies could also help. Imaging techniques developed over the last few decades that look at the chemical makeup of fossils can allow scientists to identify previously hidden details.

Still, "there often isn't a definitive answer, because there's just not enough evidence to decide for sure," Padian says. ■

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GENES & CELLS

Rat reveals limits of de-extinction

Gene editing may fall short in resurrecting defunct species

BY ANNA GIBBS

Before the early 1900s, if it walked like a Christmas Island rat and talked like a Christmas Island rat, it probably was a Christmas Island rat. But if one of these now-extinct rodents ever walks the Earth again, it will most likely be a genetically modified Norway brown rat. And it won't be as similar to the Christmas Island rat as some would hope, a new study finds.

With the advent of gene-editing technology such as CRISPR, scientists have shifted from cloning to genetic engineering as the most promising method for “de-extinction,” or the resurrection of species that have died out. But unlike cloning, genetic engineering wouldn't create an exact replica of an extinct species. Instead, the technique would edit an existing animal's genome so that it resembles that of the desired extinct animal. The challenge is making that proxy as similar to the extinct species as possible.

To explore the limits of this method, researchers attempted to recover the genome of the Christmas Island rat. By comparing fragments of the extinct rat's genetic instruction book with the genome of a living relative, the Norway brown rat, the team was able to recover about 95 percent of the extinct genome. That sounds like a lot, but it means that 5 percent of

the genome was still missing, including some regions important to the rat's sense of smell and immune system, scientists report March 9 in *Current Biology*.

“You can only bring back what you can find. And our point is we can't find everything,” says Tom Gilbert, an evolutionary biologist at the University of Copenhagen.

Gilbert and colleagues took ancient DNA from two preserved skin samples of the Christmas Island rat. With an intact copy of the genetic instruction book, someone could theoretically reconstruct the genome perfectly. An extinct species's genome, Gilbert says, is like a book that has been shredded. One way to reconstruct it is to scan the fragments and compare them with a reference.

When identifying a reference genome, researchers look for a species that diverged evolutionarily from the extinct species fairly recently—in other words, a very similar book. The genomes will match closely, but not perfectly.

For that reason, the Christmas Island rat (*Rattus macleari*) was an obvious choice for analysis. It diverged from a close relative, the Norway brown rat (*R. norvegicus*), only about 2.6 million years ago.

The Christmas Island rat genome mapped to about 95 percent of the Norway brown rat genome, the team found. Further analyses showed that the roughly 5 percent that was missing could not be explained solely by a flaw in the technique or an inadequate reference genome. Rather, because of evolutionary divergence between the two species, most of that genetic information was simply lost.

Genes that were partially or completely missing tended to fall within two main regions that controlled the rat's immune responses and sense of smell. If a Norway brown rat's genome were edited to resemble the Christmas Island rat's, the new critter would smell in a different way than the

Christmas Island rat did. This could hinder the proxy rat's chance at survival if released into the extinct animal's former habitat.

Gilbert doesn't think it's likely that anyone will try to de-extinct a rat. But, he says, what the team has demonstrated could prove useful for people working on even more ambitious projects, like bringing back the woolly mammoth. The divergence between the Norway brown rat and the Christmas Island rat, for example, is similar to that between the Asian elephant and woolly mammoth.

“By doing these kinds of analyses, which is not hard to do, you can at least come up with the ‘what will you get, what will you not get,’ and you can use that to decide is it worth doing,” Gilbert says.

Despite the hurdles, using the technology to bring back species is still worth doing, says Ben Novak, lead scientist at Revive & Restore, a nonprofit based in Sausalito, Calif., that uses genetic engineering for conservation projects. He plans to apply Gilbert and colleagues' analysis to his own work on the passenger pigeon, which went extinct in 1914. There are possible solutions for how to capture some of the missing data, he says, but the fact that some data will always be missing is a limitation that de-extinction scientists have already come to terms with.

“The reference assembly problem will always be a barrier to de-extinction,” Novak says. “Anyone pursuing de-extinction has to settle on the fact that we want to get as close as we can to something that fools the environment.”

In other words, a de-extinct mammoth created using gene editing wouldn't exactly be a mammoth; it would be closer to a hairy Asian elephant adapted to living in the cold. The new analysis suggests that this proxy version would probably have differences that make it difficult for the creature to refill the mammoth's ecological niche. For some researchers, that might be enough to defeat the purpose of the exercise.

“As a science, it's awesome,” Gilbert says. But, he asks, “is this the best use of the money in a world where we can't keep our rhinos alive?” ■



Native to an island in the Indian Ocean, the Christmas Island rat (illustrated) went extinct in the early 1900s. Scientists recreated the rodent's genome, but some key DNA was missing.

Gene therapy could become an option for hemophilia

The one-time treatment boosts levels of a blood-clotting protein, but questions remain

BY AIMEE CUNNINGHAM

A gene-based therapy is potentially a step closer toward becoming a one-time treatment for males with hemophilia. The life-threatening genetic disorder hinders the body's ability to form blood clots.

In hemophilia A, the most common type, the gene responsible for a blood-clotting protein called factor VIII has errors, leading the body to produce an insufficient amount of the protein. A new study describes how 132 males with a severe form of the disease who received one infusion of the gene therapy fared. A year later, 88 percent of the males had factor VIII levels high enough to have either no disease or a mild form, researchers report in the March 17 *New England Journal of Medicine*.

Hemophilia A is an inherited disorder. The gene that provides instructions for making factor VIII is found on the X chromosome. The condition more typically affects males than females, as it takes only one X chromosome with a faulty gene for a male to have the disease. In the United States, there are 12 hemophilia A cases per 100,000 males.

The amount of factor VIII that the body manages to produce determines the severity of the disease. People with mild disease, who have 5 to 40 percent of typical factor VIII levels, are most likely to have excessive bleeding only after injury or surgery. Moderate hemophilia, in people with levels 1 to 5 percent of the usual amount, can come with bleeding that occurs spontaneously, without a clear cause. People with severe hemophilia have next to no factor VIII, and without treatment, they face frequent, spur-of-the-moment internal bleeding that can damage the joints or brain.

But thanks to current treatment options, hemophilia patients “now have a normal life expectancy and are encouraged to live normal lives,” says Rebecca Kruse-Jarres, a hematologist at the University of Washington in Seattle and director of the Washington Center for



A man with hemophilia gives himself a treatment for the blood disorder while on a mountain in Norway. People with the disease need regular infusions of a crucial clotting protein because their bodies don't make enough. Gene therapy might eliminate the need for frequent treatments.

Bleeding Disorders. Kruse-Jarres was not involved in the gene therapy study.

The standard treatment to prevent bleeding is a replacement infusion of factor VIII, which is needed every two to three days. That means a person with severe hemophilia A could face more than 150 of these treatments a year. More recently, a monoclonal antibody that mimics the action of factor VIII has become available, giving adults and children with the disease a once-weekly treatment option.

The gene therapy, called valoctocogene roxaparvovec, consists of a one-time infusion containing genetic instructions for producing factor VIII, delivered to cells by an adeno-associated virus, which does not cause disease (SN: 5/13/00, p. 309). The virus is taken up by many different cells, but only liver cells can use the instructions to make the clotting protein.

While most people in the study saw an improvement in their factor VIII levels, the therapy did not work for a small percentage. And most participants experienced a temporary but concerning side effect: elevated levels of a liver enzyme that can signal inflammation or potential damage to

the organ. That side effect required treatment with immunosuppressants.

It's also unclear how long the effects of treatment will last. The researchers report that in 17 participants followed for two years, the clotting protein levels achieved in the first year decreased in the second year. The gene therapy can be given only once because a person would have an immune response to a second dose. More research is needed to understand the long-term durability of the treatment and the best way to manage the increased liver enzyme levels, says study coauthor and hematologist Margareth Ozelo of the University of Campinas in São Paulo.

“This will be not a treatment for all patients,” Ozelo says, but it “will benefit a group of patients in the hemophilia community.” With more work, it may be possible to learn which patients are more likely to respond well to the therapy, she says.

Gene therapy could be a wonderful option, because it would almost eliminate the burden of treatments, says Kruse-Jarres. But, she says, when considering gene therapy, “a lot of unknowns come into play.” ■

LIFE & EVOLUTION

Sex traps trick ‘murder hornets’

Scientists lure males with acids from a queen’s pheromone

BY ERIN GARCIA DE JESÚS

Male Asian giant hornets captivated by the chemical signals of a ready-to-mate queen could one day find themselves stuck in a trap instead.

In a new study, scientists identified three chemicals in the sex pheromone of Asian giant hornet queens. When traps with those chemicals were placed near the hornets’ nests in southern China — part of their native range — the traps ensnared thousands of males but no other insects, researchers report in the March 14 *Current Biology*.

The work is a step toward designing pheromone traps for these hornets, says James Nieh, a behavioral ecologist at the University of California, San Diego. Such traps are a common tool for monitoring or controlling insect populations.

Starting in 2019, nests housing Asian giant hornets (*Vespa mandarinia*) —

nicknamed “murder hornets” for their habit of feeding honeybees to their young — have popped up in a few places in western North America (SN: 7/4/20 & 7/18/20, p. 14). Studies hint that the insects could spread throughout parts of western Washington, Oregon and British Columbia in Canada, and scientists have launched efforts to control the invasion (SN: 11/7/20, p. 12). The Washington State Department of Agriculture encourages state residents to help trap the hornets using plastic bottles, orange juice and rice cooking wine.

But potent insect traps should provide “something that would ideally be irresistible,” Nieh says.

Using gas chromatography and mass spectrometry, Nieh and colleagues identified hexanoic acid, octanoic acid and decanoic acid as key components of a queen’s sex pheromone. In the lab, male hornet antennae reacted — a sign of attraction — to each of the pure compounds, as well as a mixture of the three. The team then crafted traps. Each one consisted of a sticky board, a dummy male hornet and a vial containing one of the following: one of the isolated acids, a mix of the three or extracts from a queen’s pheromone-secreting glands.



Current efforts to control invasive Asian giant hornets in North America involve finding nests (like this one collected in China, part of the hornets’ native territory). Luring males with the promise of sex may be another option.

The male hornets had a clear preference for the queen extracts, though the isolated chemicals and mixes of the three trapped many hornets as well. In one test, for example, extracts from just one gland trapped about 500 male hornets — more

BODY & BRAIN

Dopamine sends mice to dreamland

What triggers the shift to REM sleep has been a mystery

BY LAURA SANDERS

A quick surge of dopamine shifts mice into a dreamy stage of sleep.

In the rodents’ brains, the chemical messenger triggers rapid eye movement sleep, researchers report in the March 4 *Science*.

During a night’s sleep, people and other animals cycle between phases called non-REM sleep and REM, a sleep stage that usually comes with vivid dreams. But what causes those transitions is mysterious, says neurologist and sleep researcher Thomas Scammell of Harvard Medical School, who wasn’t involved in the study. The new results are some of the first to show a trigger for

the shifts, Scammell says. Understanding these transitions in more detail could ultimately point to ways to treat sleep disorders in people.

Certain nerve cells residing in a part of the mouse brain called the ventral tegmental area can pump out dopamine, a molecule that has been linked to pleasure, movement and learning, among other things. These cells can deliver dopamine to the amygdalae, two almond-shaped structures deep in the brain that are closely tied to emotions.

Using a molecular sensor that can tell exactly when and where dopamine is released, neuroscientist Takeshi Sakurai of the University of Tsukuba in Japan and

colleagues saw that dopamine levels rose in the amygdalae just before mice shifted from non-REM sleep to REM sleep.

Next, the researchers forced the mice into the REM phase by controlling those dopamine-producing nerve cells using lasers and genetic techniques — a method called optogenetics. Compelled with light, the nerve cells released dopamine in the amygdalae while mice were in non-REM sleep. The mice then shifted into REM sleep sooner than they typically did, after an average of about two minutes compared with about eight minutes for mice that weren’t prompted to release dopamine. Stimulating these cells every half hour increased the mice’s total amount of REM sleep.

Additional experiments suggest that these dopamine-making nerve cells may also be involved in aspects of narcolepsy. A sudden loss of muscle tone, known

than twice the number trapped by full concentrations of the three-chemical cocktail, which itself performed on par with two of the undiluted isolated chemicals. Control traps lacking the extracts or pure chemicals attracted few males.

Because male Asian giant hornets were most attracted to the pheromone gland chemicals compared with the individual acids or the mix, there are probably other compounds in the pheromone that could make traps even more effective, Nieh says.

It's unclear whether the traps work over longer distances. But a hornet queen's sex pheromone probably lures males from farther away to avoid incestuous inbreeding, Nieh says. The traps could be most useful in late fall during the hornets' mating season.

The finding is "important work," says Timothy Lawrence, an apiculturist at the Washington State University campus in Coupeville who wasn't involved with the study. Finding a way to attract worker hornets, not just males in search of a mate, would be great because the mating season is short. But the results are still a "major step forward," he says. "The sooner we find a reliable way to attract males and find nests, the better." ■

as cataplexy, shares features with REM sleep and can accompany narcolepsy (SN: 10/24/09, p. 24). Stimulating these dopamine-making nerve cells while mice were awake caused the mice to stop moving and fall directly into REM sleep.

The results help clarify a trigger for REM in mice; whether a similar thing happens in people isn't known, Sakurai says. Earlier studies have found that nerve cells in people's amygdalae are active during REM sleep, he says, hinting at a role for the brain structure.

Many questions remain. Drugs that change dopamine levels in people don't seem to have big effects on REM sleep and cataplexy, Scammell says. But these drugs affect the whole brain, he points out, and it's possible that they are just not selective enough. "My overall question about this is, how can we translate this to humans?" Scammell says. ■

ATOM & COSMOS

Diamonds may stud Mercury's crust

Impacts could have transformed surface graphite into gems

BY NIKK OGASA

A treasure trove of diamonds may be sown into Mercury's cratered crust.

Billions of years of impacts may have flash-baked much of Mercury's surface into the precious gemstones, planetary scientist Kevin Cannon reported March 10 at the Lunar and Planetary Science Conference in The Woodlands, Texas. His computer simulations predict that such impacts may have transformed about one-third of the little planet's crust into a diamond stockpile many times that of Earth's.

Diamonds are forged under immense pressures and temperatures. On Earth, the gemstones crystallize deep underground, at least 150 kilometers down, with some rising to the surface during volcanic eruptions (SN: 10/10/20 & 10/24/20, p. 18). But studies of meteorites suggest diamonds can also form during impact.

"When those [impacts] happen, they create very high pressures and temperatures that can transform carbon into diamond," says Cannon, of the Colorado School of Mines in Golden.

With impact-born diamonds on his mind, Cannon turned to the closest planet to the sun. Surveys of the planet's surface and experiments with molten rock suggest that the planet's crust may retain fragments of an old shell of graphite—a mineral made from carbon (SN: 4/16/16, p. 5). "What we think happened is that when [Mercury] first formed, it had a magma ocean, and that graphite crystallized out of that magma," Cannon says.

Then, the bombardments. Mercury's surface today is heavily cratered, evidence of an impact-rich history. Much of the purported graphite crust would have been battered and transformed into diamond, Cannon hypothesized.

Curious how pervasive this diamond forging could have been, Cannon simulated 4.5 billion years of impacts on a graphite crust. The findings show that

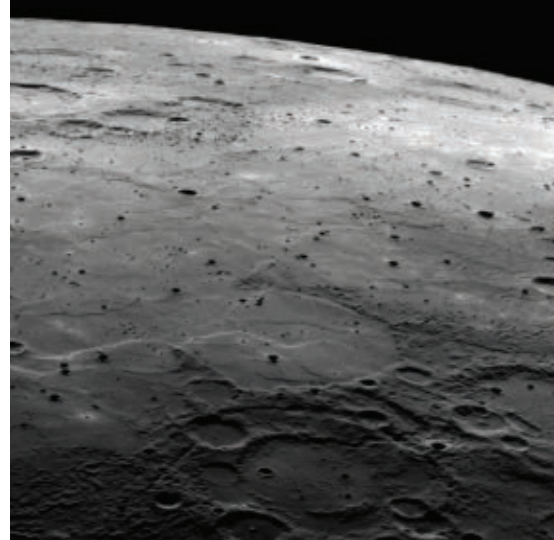
if Mercury possessed a graphite crust 300 meters thick, the battering would have generated more than 16 quadrillion tons of diamonds—about 16 times Earth's reserves.

"There's no reason to doubt that diamonds could be produced in this way," says Simone Marchi, a planetary scientist at the Southwest Research Institute in Boulder, Colo., who was not involved with the research. But how many might have survived is another story, he says. Some of the gemstones were probably destroyed by later impacts.

That's probably true, Cannon says. But the losses would have been "very limited," he adds, as the ultimate melting point of diamond exceeds 4000° Celsius. Future simulations will incorporate remelting from impacts, he says, to refine the potential size of the planet's present-day diamond reserves.

An opportunity to scout for diamonds on Mercury may come in 2025, when the BepiColombo mission starts orbiting the planet. Diamonds reflect a distinct signature of infrared light, Cannon says. "And potentially, this could be detected." ■

A persistent barrage of impacts may have turned some of the surface of Mercury (shown) into diamonds, computer simulations suggest.





What do animals feel?

Researchers are learning to gauge how some creatures experience the world **By Alla Katsnelson**

A dog gives a protective bark, sensing a nearby stranger. A cat slinks by disdainfully, ignoring anyone and everyone. A cow moos in contentment, chewing its cud. At least, that's what we may think animals feel when they act the way they do. We take our own lived experiences and fill in gaps with our imaginations to better understand and relate to the animals we encounter.

Often, our assumptions are wrong. Take horse play, for example. Many people assume that these muscular, majestic animals are roughhousing just

for the fun of it. But in the wild, adult horses rarely play. When we see them play in captivity, it isn't necessarily a good sign, says Martine Hausberger, an animal scientist at CNRS at the University of Rennes in France.

Hausberger, who raises horses on her farm in Brittany, began studying horse welfare about three decades ago, after observing that people who keep horses often misjudge cues about the animals' behavior.

Adult horses that play are often ones that have been restrained, Hausberger says. Play seems to



FROM LEFT: ALAN TRAVERS/MOMENT OPEN/GETTY IMAGES
PLUS: PETER CADE/STONE/GETTY IMAGES PLUS

discharge the stress from that restriction. “When they have the opportunity, they may exhibit play, and at that precise moment they may be happier,” she says. But “animals that are feeling well all the time don’t need this to get rid of the stress.”

Scientists studying animal behavior and animal welfare are making important strides in understanding how the creatures we share our planet with experience the world. “In the last decade or two, people have gotten bolder and more creative in terms of asking what animals’ emotional states are,” explains Georgia Mason, a behavioral biologist and animal welfare scientist at the University of Guelph in Canada. They’re finding thought-provoking answers amid a wide array of animals.

For instance, recent studies hint that picking up a mouse by its tail casts a pall on the animal’s day, and that an unexpected sugar treat may improve a bee’s mood. Crayfish might experience anxiety; ferrets can get bored; and octopuses, and perhaps

fish, can experience pain.

Such findings could drive changes in how we treat the animals in our care. For instance, a broad scientific review published in November 2021 by the London School of Economics and Political Science concludes that certain invertebrates such as crabs, lobsters and octopuses should be considered sentient — that is, capable of subjective experiences such as pain and suffering. The conclusions suggest that protection afforded by animal welfare laws should extend to these creatures. One possible outcome: Updates to U.K. animal welfare legislation may make it illegal to boil lobsters alive, requiring swifter, less painful methods to kill the animals.

Yet studying what animals experience is a challenge, says Charlotte Burn, an animal welfare scientist at the Royal Veterinary College in Hatfield, England, and an author of the 2021 review. Researchers can make scientific inferences about how an animal feels based on observable clues

Animal welfare researchers are devising ways to study the emotions and subjective experiences of a wide variety of animals.



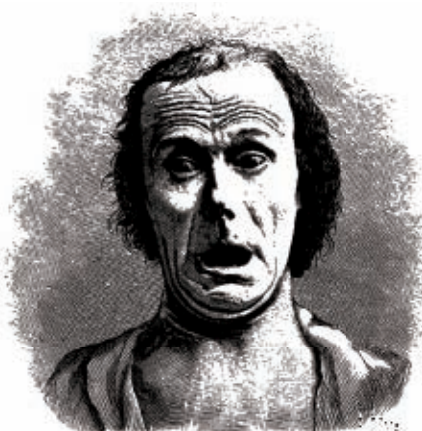
A small EEG headset measures a horse's brain waves to gauge its state of well-being. Horses that were able to graze freely with a herd had more slow theta waves than horses that spent more time restrained alone in a stall. In humans, such waves reflect calmness.

from physiology or behavior, she says. But feelings are subjective. “So doing science about this is a bit strange,” Burn says, “because you have to get comfortable with the fact that your key thing is unknowable.”

Horse sense

To study horse welfare, Hausberger doesn't focus on how emotions such as happiness or sadness may manifest in any given moment. She's interested in a horse's overall emotional picture — as she puts it, “the chronic state of feeling more positive

In his book *The Expression of the Emotions in Man and Animals*, Charles Darwin argued that animals experience emotions similar to those of humans thanks to a shared evolutionary history. Illustrations showed a terrified human, a sulking chimpanzee and a hostile dog.



or negative emotions.”

To determine how content a horse is with its life, people who care for horses would typically look at things like ear position, posture and how attentive the horse is to its environment. Blood markers for anemia, indicating chronic stress, and signs of overall wellness such as appetite and immune system health could also shed light.

Recently, Hausberger and her colleagues tested a more specific and direct measure: the brain waves of horses, collected using electroencephalography, or EEG.

In people, EEG can help assess sleep patterns or diagnose conditions such as epilepsy, stroke or head injury, and researchers now think certain types of brain waves can indicate depression. EEG has been used in animals in veterinary clinics and in laboratory studies, but Hausberger wanted to bring the tool to the animals' home turf.

Her team created a simplified, portable EEG device that provides “a sort of summary of brain activity,” she says. Five electrodes are placed on a horse's forehead, attached to a lightweight headset.

The researchers used this headset EEG to gauge the welfare of 18 horses that wore the device for six 10-minute observations. The results, published March 2021 in *Applied Animal Behaviour Science*, give a snapshot into the secret lives of horses.

The horses that roamed with their herd outdoors, grazing at will, had more brain waves called theta waves, which have high amplitude and move slowly. In humans, theta waves are thought to reflect calm and well-being. By contrast, the animals that lived in solo stalls with little contact with other horses had more gamma brain waves, the fastest of all brain waves. In people, gamma waves are associated with anxiety and stress.

FROM TOP: CELINE ROCHAIS; C. DARWIN/THE EXPRESSION OF THE EMOTIONS IN MAN AND ANIMALS 1872

Shared evolutionary history

For most of the last two millennia, Western thinkers roundly rejected the notion that animals have the capacity for feelings. Charles Darwin bucked that trend, proposing a shared evolutionary capacity for emotion across species in his 1872 book, *The Expression of the Emotions in Man and Animals*. Take fear, for example: “With all or almost all animals, even with birds, Terror causes the body to tremble,” he wrote.

But a psychological theory called behaviorism, which gained prominence in the early 20th century, put a decades-long pall on research into animals’ inner lives. Behaviorists dismissed the prospect of studying subjective experiences, holding that “if you can’t measure it, don’t make up stories about it,” Mason says.

That started to change near the end of the 20th century. For example, in the 1980s, animal welfare researcher Marian Stamp Dawkins of the University of Oxford began probing how animals experience the world. Her studies gave creatures an opportunity to demonstrate what they wanted and how much of a cost they would pay to gain it. Researchers still ask such questions. For instance: How heavy a door would a hen push for the chance to perch at night?

Another approach involves investigating animals’ feelings through the lens of human psychology. Looking for parallels in how humans and other animals process experiences makes sense because our brains and behaviors reflect a shared evolutionary history, says Michael Mendl, an animal welfare researcher at the University of Bristol in England. Researchers routinely probe the minds and brains of rodents and other animals, including flies, fish and primates, to study and develop drugs for human mental disorders such as depression and anxiety. So we should be able to work backward from humans to study feelings in other animals too, Mendl says.

Mood matters?

Mendl and psychologist Elizabeth Paul, also at the University of Bristol, narrowed in on one well-known feature of human psychology. People’s emotional states, negative or positive, bias their thoughts and decisions. Psychologists use the term “affect” for these overarching mental states.

Affect acts as a filter through which one sees the world — rose-colored or turd-smear glasses, you

could say — that is often shaped by positive or negative experiences. Mendl, Paul and graduate student Emma Harding devised an experiment in the early 2000s that sought to parse whether experiences that might influence a rat’s affect can change the decisions it makes.

The researchers first taught the rats to associate one tone with a positive stimulus (a tasty treat) and another tone with a negative stimulus (an unpleasant noise). The rats learned to press a lever when they heard the positive tone, and not to when they heard the negative one. Then, the researchers placed the animals in either a pleasing, predictable living environment or an annoyingly variable one.

A few days later, for each animal, the researchers played a beep with a wavelength right between the positive and the negative tones. The animals that had lived in the pleasing cage pressed the lever, hinting that they were optimistic that pressing the lever would yield a treat. The ones that lived in the unpredictable cage left the lever alone, or were slower to press it, suggesting they were more pessimistic.

“What we think our test shows is that the animal is in a positive or negative affective state,” Mendl explains. To put it more plainly: The rats’ behaviors could mean that they

judged the tone based on whether they felt good about the world. Since that study, researchers have used this task and variations of it to gauge positive and negative affect in at least 22 species, including mammals, birds and insects.

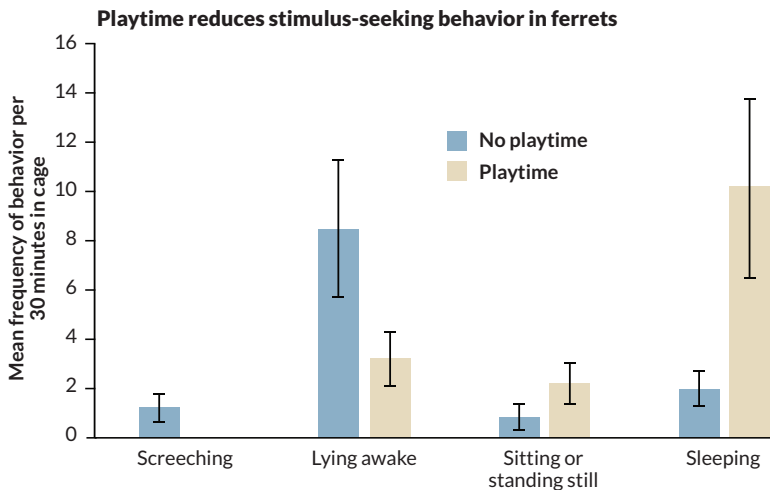
But there’s an important caveat, Mendl says. The experiment, called a judgment bias task, points to whether an animal is experiencing something in its life positively or negatively. However, the task doesn’t demonstrate something more basic — whether an animal can have subjective experiences to begin with.

Animal welfare studies assume that animals are sentient, because if they weren’t, talking about their well-being wouldn’t make sense, Mason says. “But none of the measures we use can assess or check that assumption, because we simply don’t yet know how to assess sentience,” she notes.

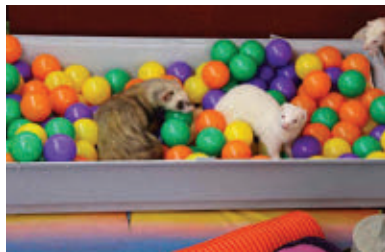
Searching for emotional life

Mason posits that some animal experiences are probably species-specific. For group-living animals like sheep, for example, “to be isolated probably induces a form of terror that ... humans

Another approach involves investigating animals’ feelings through the lens of human psychology.



Relieving boredom Ferrets living in lab cages were given extra playtime (right) to reduce boredom some days and not others. On days when animals got no extra playtime, they more often screeched and lay awake with eyes open, and slept and stood less than when they had extra playtime. The rise in restless behavior may indicate higher levels of boredom. SOURCE: C.C. BURN, J. RAFFLE AND J.K. BIZLEY/ANIMAL WELFARE 2020



can't imagine," Mason says. Or, for creatures like homing pigeons that can sense magnetic fields, being put in a strong magnetic field "may be very upsetting in a way that we don't have a name for," she says.

But many other feelings could be shared. For example, a sizable body of evidence suggests that stressors from life in captivity can cause depression in animals. What about boredom?

Mason and her colleagues reasoned that a depressed animal would lose interest in its surroundings, but a bored animal might be drawn to both negative and positive stimuli, just to get a reprieve from monotony. That's what the group showed in 2012. Male minks sought out pleasant experiences — like the smell of female poop, a treat during mating season — but also neutral ones like plastic bottles and even threatening ones like the big leather gauntlets farmers use to catch minks.

Building on Mason's work, Burn, at Royal Veterinary College, recently found a similar dynamic in ferrets living in a lab. The animals sought out the pleasure of a good whiff of mouse bedding, as well as the distasteful smell of peppermint oil, and they tended to be both drowsy and restlessly aggressive.

Relieving the animals' boredom with extra playtime turned their interests away from the negative, Burn and her colleagues reported in February 2020 in *Animal Welfare*.

Pain in two parts

Pain, too, is experienced by many animals. Pain has two components, says behavioral and welfare scientist Matthew Leach of Newcastle University in England. One component is physical, simply consisting of the activation of sensory receptors, nerve cells firing or other physiological features — pain's plumbing, you could say. Animals respond to it with a reflex reaction or a basic learned response; no conscious awareness is required.

The other component is emotional, which is trickier to measure because it manifests in more complex behaviors. For example, mice, which like an ambient temperature up to 10 degrees Celsius higher than in most research labs, build intricate nests in their cages that help them regulate body temperature. When the animals are in pain or distress, their nest-building abilities fall apart.

Facial expressions are a more direct way to assess pain or other types of distress in animals, Leach says. His lab team and others have identified a range of expressions in more than a dozen species, from mice to horses. With less than 30 minutes of training, people can learn to accurately see grimaces in animals' faces, Leach says.

Those faces can reveal more than pain. Using artificial intelligence algorithms to scan videos of mouse faces, researchers have identified a whole range of emotions — pleasure, disgust, fear — encoded in the tilt of the ears or a curl of the nose (SN: 5/9/20 & 5/23/20, p. 16). "We're still very much in the infancy of understanding what facial expressions are telling us," Leach says.

Researchers can often infer from an animal's behavior that it is in pain, Leach says. But making such inferences about animals that are very different from us is more challenging. Take octopuses, for instance. Their three-lobed brain "is as far from a vertebrate as you could possibly ever get," he says. That evolutionary distance may mean octopuses respond to stimuli differently.

To probe that question, Robyn Crook, a neuroscientist at San Francisco State University, used a learning task to show that octopuses might in fact experience the emotional component of pain, reporting the results on February 22, 2021, in *iScience*. She first let octopuses loose in a box with three rooms, and each octopus naturally gravitated to a room it preferred.

Then Crook injected the animals with either saline, a slightly painful stimulus (an under-the-skin injection of acetic acid, the acerbic agent in vinegar) or the painful acid along with a pain-relieving medicine. She then put the animals injected with

acetic acid into the chamber they preferred most, and the ones injected with acetic acid and the pain killer into the chamber they had liked least. The idea was to allow the octopuses to associate how they felt with the chamber, Crook explains.

A few hours later, after the painful stimulus would have worn off, Crook let the animals explore the three rooms again. The octopuses that got the painful shots avoided their originally preferred room, suggesting they associated it with pain. Those that got the shots with the medicine now preferred the room they had originally disliked, suggesting they associated it with relief from pain. Matching their negative experience in the room with their later experience out of it requires a kind of “mental time travel” that hints at emotional awareness, Crook says. Not everyone agrees with this interpretation. “It is very difficult to produce convincing evidence of affective state in an animal that’s very unlike us,” she says — at least in part because of how mammalian-centric our assumptions tend to be.

A matter of ethics

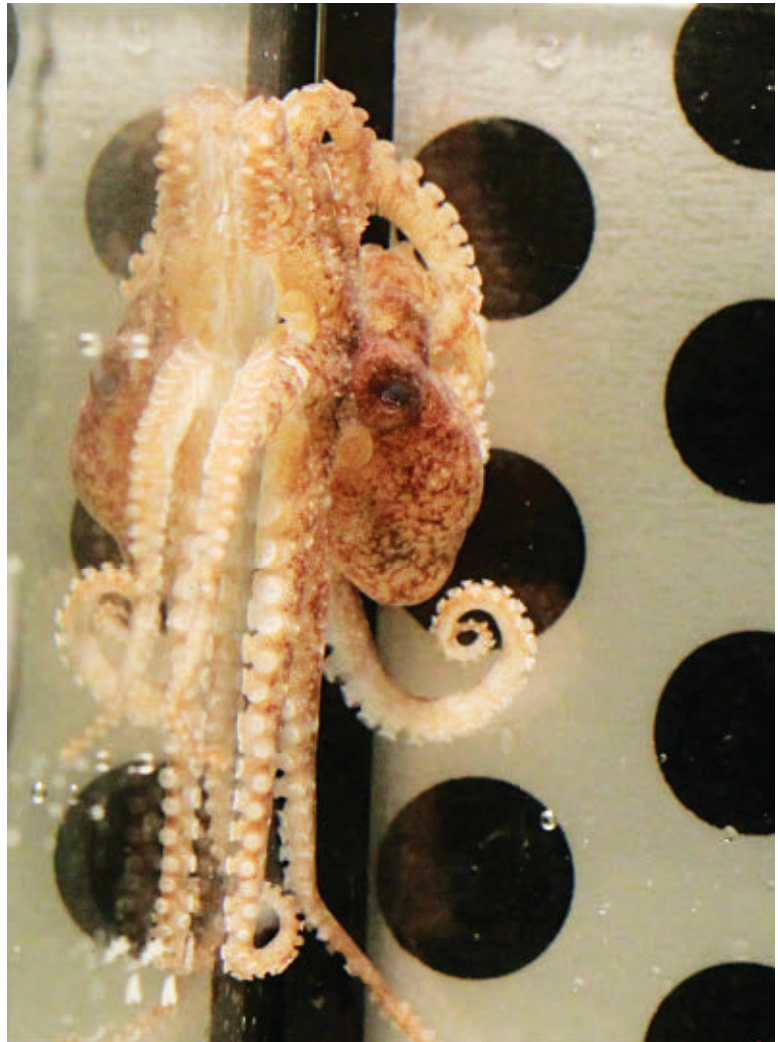
Still, notes Mason, from an ethical and practical point of view, being cautious and treating octopuses as if they do feel pain “is wise and humane.” But researchers are still figuring out where to draw the line across the animal kingdom.

That question prompted the recent U.K. scientific assessment of sentience. The researchers involved reviewed all the literature they could find that might point to clues about the inner lives of cephalopods and crustaceans — studies on behavior and physiology, neuroanatomy and common practices in the seafood industry.

The group’s eight-point checklist considered factors such as whether an animal’s nervous system could integrate different types of sensory information, and the complexity of the animal’s pain-sensing machinery.

“There’s a lot of information out there about animal behavior that is actually relevant to questions of sentience in a way that hasn’t always been appreciated,” says report author Jonathan Birch, a philosopher of science at the London School of Economics and Political Science. But for these species, “there’s not been a lot of intentional investigation.”

Ultimately, says Burn, the group hedged its bets — not because they were sure, but because “the body of evidence is starting to make us think [the animals] deserve the benefit of the doubt,” she says. As researchers settle on ways to parse different emotional states — and on a more basic



This octopus explores a three-chambered box during an experiment that found octopuses avoid locations where they had experienced a painful sensation. The finding suggests that the animals may experience and remember pain on an emotional level.

level, perhaps even ways to identify sentience — we might find a wider basis for a shared inner life across the animal kingdom. ■

Explore more

- Jonathan Birch *et al.* *Review of the Evidence of Sentience in Cephalopod Molluscs and Decapod Crustaceans*. November 2021. bit.ly/cephalopodsentience
- Elizabeth S. Paul *et al.* “Towards a comparative science of emotion: Affect and consciousness in humans and animals.” *Neuroscience & Biobehavioral Reviews*. January 2020.

Alla Katsnelson is an independent science journalist based in Northampton, Mass.



When an Anime Convention Meets COVID-19

Masks, vaccine requirements and other safeguards kept most fans from getting sick **By Betsy Ladyzhets**



As Kristin Meyer set up her merchandise booth at the Anime NYC convention last November, she was sure she'd be exposed to the coronavirus at some point during the three-day event. "Getting that many people together in one spot, the chance that absolutely no one had COVID was zero," she says.

Meyer was one of hundreds of artists who paid for a space to sell their art in the convention's Artist Alley. Many signed up, despite getting a cold or the flu, bronchitis or pneumonia at previous fan

conventions. "I used to get everything," says Daifei, another artist, who asked to be referred to by their online handle. "Just from being around people."

Anime NYC, first held in 2017, has become a beloved meeting place for fans of Japanese cartoons known as anime and comics called manga. Fans wearing elaborate anime-inspired costumes enter contests and pose for group photos. Actors who voice popular characters speak on panels and meet attendees for autographs. Media companies offer exclusive previews of their upcoming releases.

In the Artist Alley, attendees buy anime-inspired prints, charms, buttons and other custom-made merchandise. At an event like Anime NYC, artists can make as much as \$15,000 in a weekend, says Daniela Muino, an artist who traveled from Texas with her partner to the 2021 convention. "People physically seeing your art in front of them" is great for sales, Muino says.

The greatest draw of Anime NYC for many attendees is connecting with other fans. A hobby typically considered niche takes over one of the country's largest convention centers — the Javits Center — and drives a three-day party in and around the venue. Even in the midst of a pandemic, the 2021 event drew a record 53,000 attendees from around the United States and 30 other countries.

People were clearly drawn to get together. "Self-isolating rules are vital [in a pandemic]," says Robin Wollast, a psychology researcher at Stanford University. But "they also undermine deep-rooted needs for social bonding." In-person events can be crucial for mental health, he says, despite the health risks they pose.

Attendees aware of those risks were not surprised when news broke in early December that the convention may have been a superspreader event; one of the first U.S. cases of COVID-19 due to the highly contagious omicron variant had been traced back to Anime NYC. The shock came later, in February, when the U.S. Centers for Disease Control and Prevention reported that, in fact, omicron had not spread widely at the convention.

Anime NYC may offer some lessons for making large events safer now and in the post-pandemic future.

What went right?

Peter McGinn, who works in health insurance, felt confident flying to New York City from his Minneapolis home for the convention. The 31-year-old knew the virus spreads easily through the air. But he was fully vaccinated and boosted, as were many of his 30 or so friends coming in from more

Attendees at last November's Anime NYC dressed up as characters from *Cells at Work!*, a Japanese manga series featuring anthropomorphized cells of the human body. And most masked up.

than 10 states. The group used Anime NYC as a long weekend party; they shared accommodations and socialized at the city's restaurants, bars and karaoke venues.

"I felt pretty comfortable based off of everything I did to protect myself, and what the people I was with did to protect themselves and everybody around us," says McGinn, referring to his friends' vaccination status and their masking in the venue, except when eating or drinking.

Once back in Minneapolis, McGinn didn't feel great, but he attributed his symptoms to "normal con fatigue." Plenty of attendees of these and similar events expect to get sick. At the American Geophysical Union's annual meeting, for example, attendees ruefully refer to "AGU flu," which spreads among conference-goers every year.

When one of McGinn's convention friends tested positive for COVID-19, McGinn took a PCR test, which came back positive. A week into his 10-day quarantine, the Minnesota Department of Health called to tell McGinn that he was the first known person in his state to be infected with the omicron variant. Once the health department learned he had been to the crowded convention in New York City, McGinn spent hours helping both Minnesota's state agency and the CDC with contact tracing.

Once word got out that McGinn had omicron and that several of his convention-going friends had also tested positive, news reports suggested he may have been patient zero for a potential superspreader event at the anime convention.

This news was reminiscent of the February 2020

biotech conference in Boston that had become one of the first superspreader events in the United States. Infections at that conference may have been linked to more than 300,000 cases, researchers reported in *Science* in December 2020.

In January, McGinn said he hoped the investigation into Anime NYC would push back against the perception that this convention had been a superspreader. "It's overwhelmingly likely that where I caught COVID was outside of the event at dinner or karaoke," he says. While at the convention center, he and his friends constantly wore masks.

McGinn felt vindicated when the results of the investigation were published as a pair of reports in the Feb. 18 *Morbidity and Mortality Weekly Report*. One study focused on McGinn and his friend group, and the other presented a big-picture view of COVID-19 at the convention. The researchers searched state and local health databases for test results from about 34,500 out of the 53,000 convention attendees whose contact information was available from the event organizers. They identified 119 cases among 4,560 people who got tested. Of those 119 cases, 16 were in McGinn's friend group—and the only cases confirmed as omicron were among those 16.

The CDC characterizes a superspreader event as one infectious person giving the coronavirus to many others at a rate higher than average transmission. This didn't occur at Anime NYC, the investigation found, because the rate of positive tests among convention attendees was close to the overall rate in New York City two weeks after the convention: about 3 percent.

In the early days of the pandemic, the Javits Center, shown here on March 27, 2020, became a hospital for treating people sick with COVID-19 and was fitted with high-quality air filtration.



BRYAN R. SMITH/AFP VIA GETTY IMAGES

“It’s nice to confirm that the event wasn’t a spreader event,” McGinn said after receiving news of the reports. “It makes me more comfortable in the future going to these types of events as long as mask and vax requirements are in place.”

Layers of protection

The CDC reports attribute this convention’s success to layers of safety measures put in place, including masks, vaccine checks and good ventilation.

“Everyone was always wearing their masks... when speaking to me or walking past my table,” Meyer says. She notes, however, that some costumed attendees took their masks off for photo shoots. And the Artist Alley was also located near the food court, where attendees took off their masks to eat.

Muino was impressed by the safety behaviors she saw at the convention in comparison with her home state of Texas. Still, the spacing of tables in Artist Alley “felt way too close together” for social distancing, she recalls. During busy periods, the area became incredibly crowded.

“There’s only so much control you can exert over a population that large,” Muino says. “People are going to take their masks off for pictures. They’re going to take them off to talk to friends.”

Attendees needed to show proof that they’d received at least one vaccine dose, following the city’s regulations at the time. Among 3,845 attendees whose test results and vaccination status were both available from local health departments, 3.4 percent were partially vaccinated, 84.5 percent were fully vaccinated and 12.1 percent had received a booster dose. Studies have shown that partial vaccination offers significantly less protection against COVID-19 than full vaccination.

However, Anime NYC organizers had too few staff checking proof of vaccination outside the venue, leading to long lines and crowding outside. Some attendees waited outside up to four hours on the first day of the convention.

The Javits Center itself took COVID-19 seriously, partly due to its roles during the pandemic as a field hospital and then a mass vaccination site. Newly installed hospital-grade air filters throughout the building may have helped prevent transmission.

“All the employees at the Javits Center had to go through training,” says Gavin Macgregor-Skinner, senior director of the Global Biorisk Advisory Council, part of the worldwide cleaning industry association that certifies organizations, including the Javits Center, on preparedness for biological threats. This training included cleaning protocols and how to manage traffic through the building.

Recipe for success

Convention venues and organizers can choose from a menu of options to help keep patrons safe from COVID-19 and other infectious diseases, says Mark Billik, founder of the marketing company BeCore, which organizes COVID-19–safe events.

For safe arrival and to avoid overcrowding at the venue entrance, provide:

- Enough staff to check vaccination cards
- Advanced verification of vaccine status
- Staggered arrival times
- Pre-event rapid testing



For social distancing inside the venue:

- Put designated eating areas away from main convention halls
- Provide outdoor eating areas with heaters (in winter)
- Offer wristbands so attendees can signal their comfort level with personal contact, such as hugs
- Make it easy to cancel if sick, without financial loss
- Mail a mask, rapid tests and hand sanitizer to attendees

E-mail or text reminders to attendees:

- Get vaxed in plenty of time before event
- Review the event’s safety protocols
- Stay home if you don’t feel well



This venue also worked with event organizers, including the company that runs Anime NYC, to ensure they followed safety protocols. The Javits Center’s attitude was, “if you come into our house, you follow our rules,” Macgregor-Skinner says.

The CDC investigation results do not mention, however, that Anime NYC was also very lucky with its timing. When this event took place, omicron hadn’t yet gotten a foothold in Manhattan. The city’s first wastewater samples containing omicron were collected on November 21, the final day of the event.

If the same event had happened two weeks later – when omicron was raging through the city – organizers would have needed more safety measures, such as a stricter vaccination requirement and rapid testing, to achieve the same low transmission, says Ayman El-Mohandes, an epidemiologist and dean of the school of public health at the City University of New York.

Heroes wear face masks

A successful COVID-19–safe event requires layers of protections that align with the community that the event is serving, says Mark Billik, founder of BeCore, a marketing agency that pivoted to organizing COVID-19–safe events during the pandemic.

Friends shared their Artist Alley merchandise spoils at Anime NYC.



Billik recommends that his clients tailor their COVID-19 protocols for their events and he offered suggestions for future fan conventions (see Page 25).

Advance communication may be particularly successful when it's tailored to a community and drives "enthusiasm about creating a safe environment," El-Mohandes says. For instance, the next Anime NYC could provide masks with the faces of famous anime characters or post signs that show these characters encouraging distancing and frequent handwashing.

Using anime characters to promote safe behaviors is an example of classical conditioning, says Wollast, the Stanford psychology researcher. In classical conditioning, people learn to associate a particular stimulus (like wearing a face mask) with an unrelated stimulus (a favorite character) to drive a particular behavior. "My heroes are wearing face masks so I should wear one too," Wollast says.

Safety beyond COVID-19

Along with avoiding COVID-19, Anime NYC attendees who spoke to *Science News* noted that they also avoided other respiratory illnesses. "Less people have been sick that I've heard of this year, than any other convention that I've ever been to," Daifei says.

Maybe a cold or flu doesn't have to be a necessary evil of attending conventions or similar events.

COVID-19 safety measures probably contributed to an unusually low number of flu cases in the 2020–21 season, according to the CDC. Leaders in the events industry are considering safety measures that build on lessons from COVID-19 — such as new technologies to improve ventilation and cleaning protocols — to reduce future outbreaks of

flu and other infectious diseases, according to the Global Biorisk Advisory Council.

Some Anime NYC attendees hope to see continued handwashing, mask use and policies that encourage people to stay home when not feeling well, long after this pandemic recedes. All these practices are "very applicable to non-COVID respiratory infections," El-Mohandes says. Such safety practices may also make large events more inclusive for immunocompromised people, many of whom already had to avoid crowds for their potential to spread infection before the pandemic.

"I feel like this is something that we can actually keep doing," says Nicole Tan, an artist who shared a booth with Daifei at Anime NYC. The pandemic inspired a widespread realization that "we could have prevented a lot of illness if we just put our minds to it." ■

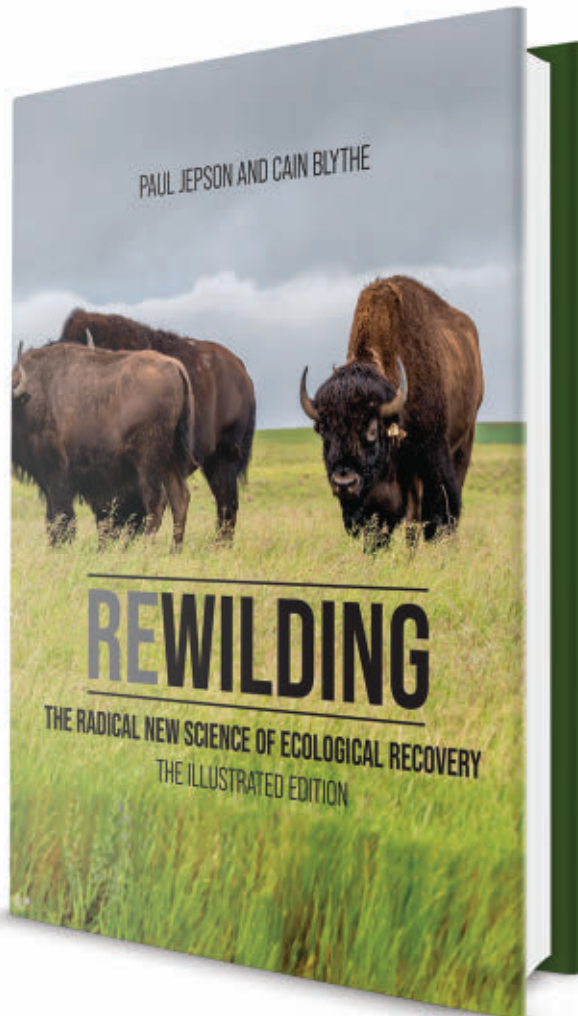
Explore more

- Samira Sami *et al.* "Investigation of SARS-CoV-2 transmission associated with a large indoor convention — New York City, November–December 2021." *Morbidity and Mortality Weekly Report*. February 18, 2022.
- Sarah E. Smith-Jeffcoat *et al.* "Multistate outbreak of SARS-CoV-2 B.1.1.529 (omicron) variant infections among persons in a social network attending a convention — New York City, November 18–December 20, 2021." *Morbidity and Mortality Weekly Report*. February 18, 2022.

Betsy Ladyzhets is a freelance science, health and data journalist based in Brooklyn, N.Y.

Why we need to talk about rewilding right now

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Rewilding, a term coined in the 1990s, is now entering the mainstream of scientific and popular debate on how to govern the complex relationship between human societies and nature. The number of scientific papers and media articles with rewilding in their title is growing exponentially, and a critical mass is building, calling for a shift from a defensive focus on nature protection to a proactive agenda of nature recovery.

In our view, rewilding signifies the coming together of three interacting developments:

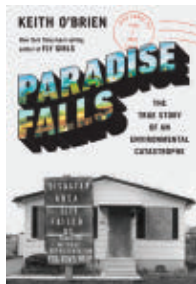
- theoretical advances in ecosystem and interdisciplinary conservation science
- innovations in natural area management
- a desire, or perhaps a need, for a new, hopeful, and empowering environmental narrative

Rewilding invites and requires a willingness to reassess, revise, and reimagine deeply held beliefs on what is natural, what species should and should not be where, and what constitutes “best” conservation practice.

The aim of our new book, *Rewilding: The Radical New Science of Ecological Recovery* is to offer an accessible synthesis of the science, practice, and politics of rewilding. Our hope is that it will motivate and empower you to reexamine and reflect on your own views of what is possible in nature conservation and leave you with a renewed sense of clarity and purpose.

In addition to reading the book, we encourage you to visit rewilding areas, engage in considered debate on the merits of rewilding and actively engage in helping to shape a rewilding movement.





Paradise Falls
Keith O'Brien
PANTHEON, \$30

BOOKSHELF

Paradise Falls thrusts readers into the Love Canal disaster

In December 1987, my family moved from sweltering Florida to a snow-custed island in the Niagara River just north of Buffalo, N.Y. There on Grand Island, I heard for the first time about a place called Love Canal. Right across the river, not a mile away, lay an entire neighborhood that had been emptied out less than a decade before by one of the worst environmental disasters in American history.

In the 1940s and '50s, Hooker Chemical dumped about 20,000 tons of toxic waste into the canal, eventually covering it with soil and selling the land to the city of Niagara Falls for a dollar. The city built a school on it, and houses sprang up around it. For years, residents would smell strange odors in their homes, and kids would see chemicals bubbling up on the playground, but it wasn't until the late 1970s that local officials began to take notice. Eventually, testing revealed dangerous levels of toxic chemicals along with increased rates of certain cancers in adults, as well as seizures, learning disabilities and kidney problems in children.

To me as a kid, the area surrounding Love Canal was an eerie abandoned neighborhood where teenagers would drive around at night to get creeped out. The place is truly haunting. The stories I heard of toxic chemicals gurgling up in people's backyards stayed with me, and in 2008, I returned as an environmental reporter to write about Love Canal's legacy. Only then did I understand the magnitude of the crisis.

And only now, with the publication of *Paradise Falls*, do I fully comprehend the human tragedy of Love Canal and the neighborhood called LaSalle that straddled it. Journalist Keith O'Brien chronicles events primarily through the lens of the people who lived there. He focuses on the period from Christmas 1976 to May 1980, when President Jimmy Carter signed a federal emergency order that evacuated more than 700 families.

Having covered the story myself, I was puzzled at first to see that O'Brien covered such a tight time frame in a story that developed over decades. He skims quickly through the history of chemical dumping and touches only briefly on follow-up studies of residents in the 1980s. But he fills more than 350 pages with a narrative of the main crisis period so gripping it could almost be a thriller. As the disaster unfolds, there are horrific discoveries, medical mysteries and plenty of screaming neighbors. The whole narrative is pulled directly from O'Brien's extensive research, including interviews and documents that had been stored for decades.

Chapters hop between the perspectives of key residents and the scientists and officials dealing with the crisis, but the story is told chronologically and in great detail. In fact, there's so much detail that we even learn the type of cookies (oatmeal) served to the officials from the U.S. Environmental



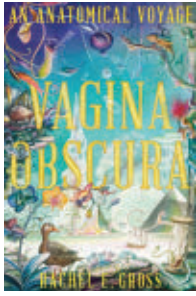
Lois Gibbs and other activists brought attention to the environmental disaster that unfolded at Love Canal in Niagara Falls, N.Y., in the late 1970s. Here, Gibbs leads a tour of the former dump site in 2008.

Protection Agency who housewife-turned-activist Lois Gibbs famously took hostage in a publicity stunt.

O'Brien's previous book, *Fly Girls*, was about pioneering female aviators of the 1920s and '30s. So perhaps it's no surprise that he has again focused on heroines. Gibbs was the public face of Love Canal, but many of the other women who took action got far less attention. O'Brien brings their stories to light. There was Elene Thornton, a Black resident of public housing who fought for her neighbors; Bonnie Casper, a young congressional aide who rallied government action; and Beverly Paigen, a scientist who risked her job studying a problem her superiors wanted to drop.

But perhaps the most poignant story, told in heartbreaking detail, is that of Luella Kenny. She was a cancer researcher living with her family in a house that backed up to a creek near Love Canal when her 6-year-old son Jon Allen fell ill with mysterious symptoms. Doctors ignored her at first, but eventually the child grew so sick he was hospitalized with a kidney disease called nephrotic syndrome.

O'Brien narrates the family's days with stunning clarity, capturing small but moving moments like Jon Allen gathering fallen chestnuts in the hospital parking lot and rolling them between his small, swollen fingers. By the time I read of Jon Allen's death, even though I already knew the outcome, I cried. I felt as if I knew these people personally by the end of the book, and any misgivings I had initially about O'Brien's approach disappeared. There are many ways to tell a story, but sometimes the simplest way—the perspective of those who lived it—is best. —Erika Engelhaupt



BOOKSHELF

The female body gets belated attention

More than 2,000 years ago, Hippocrates, the Greek physician often considered the father of modern medicine, identified what came to be known as the clitoris, a “little pillar” of erectile tissue near the vagina’s entrance. Aristotle then noticed that the seemingly small structure was related to sexual pleasure.

Vagina Obscura
Rachel E. Gross
W.W. NORTON & CO.,
\$30

Yet it wasn’t until 2005 that urologist Helen O’Connell uncovered that the “little pillar” was just the tip of the iceberg. The internal parts of the organ reach around the vagina and go into the pelvis, extending a network of nerves deeper than anatomists ever knew.

It took millennia to uncover the clitoris’s true extent because sexism has long stymied the study of female biology, science journalist Rachel E. Gross argues in her new book, *Vagina Obscura*. Esteemed men of science, from Charles Darwin to Sigmund Freud, viewed men as superior to women. To be male was to be the ideal standard. To be female was to be a stunted version of a human. The vagina, the ancient Greeks concluded, was merely a penis turned inside out, the ovaries simply interior testicles.

Because men mostly considered women’s bodies for their reproductive capabilities and interactions with penises, only recently have researchers begun to truly understand the full scope of female organs and tissues, Gross shows. That includes the basic biology of what “healthy” looks like in these parts of the body and their effects on the body as a whole.

Vagina Obscura itself was born out of Gross’ frustration at not understanding her own body in the wake of a vaginal infection. After antibiotics and antifungal treatments failed due to a misdiagnosis, her gynecologist prescribed another treatment. As Gross paraphrases, the doctor told her to “shove rat poison up my vagina.” The infection, it turned out, was bacterial vaginosis, a hard-to-treat, sometimes itchy and painful condition caused by an overgrowth of bacteria that normally reside in the vagina. (The rat poison was boric acid, which is also an antiseptic. “It’s basically rat poison,” the doctor said. “You’re going to see that on the internet, so I might as well tell you now.”)

The book’s exploration of female anatomy begins from the outside in, first traversing the clitoris’s nerve-filled external nub to the vagina, ovaries and uterus. The last chapter focuses

on gender affirmation surgery, detailing how physicians have transformed the field for transgender people. (Gross is upfront that words such as *women* and *men* create an artificial binary, with seemingly more objective terms like “male” and “female” not performing much better in encompassing human-kind’s diversity, including intersex and transgender people.)

Throughout this tour, Gross doesn’t shy away from confronting the sexism and prejudices behind controversial ideas about female biology, such as vaginal orgasms (versus coming from the clitoris) and the existence of the G-spot. Both “near-mystical” concepts stem from the male perspective that sexual pleasure should be straightforward for women, if only men could hit the right spot. Nor are the more appalling offenses swept under the rug, including racism, eugenics and female genital cutting. Footnotes throughout the book detail Gross’ efforts to navigate controversial views and stigmatizing or culturally charged terminology.

To lift readers’ spirits, she finds the right spots to deliver a dose of wry humor or a pun. She also shares stories of often

forgotten researchers, such as lab technician Miriam Menkin, who showed in 1944 that in vitro fertilization is possible. Yet Menkin’s role in describing the first instance of a human egg being fertilized in a lab dish has largely been erased from IVF’s history (SN: 6/19/21, p. 16). There’s also plenty of opportunity to marvel at the power of the female body. Despite the long-held notion that a person is born with all the eggs they’ll ever have, for example, researchers are now discovering the ovary’s regenerative properties.



Vagina Obscura chronicles what little is known about female organs, including the vagina, uterus and ovaries, and how scientists are filling in the details.

Studying female bodies more closely could ultimately improve quality of life. Chasing cells capable of producing more eggs might bring about discoveries that could restore the menstrual cycle in cancer patients rendered infertile by chemotherapy or make menopause less miserable. Patients with endometriosis, a painful disorder in which uterine tissue grows outside the uterus, are often dismissed and their symptoms downplayed. Some doctors even recommend getting pregnant to avoid the pain. But people shouldn’t have to suffer just because they aren’t pregnant. Researchers just haven’t asked the right questions yet about the uterus or endometriosis, Gross argues.

Vagina Obscura reinforces that female bodies are more than “walking wombs” or “baby machines.” Understanding these organs and tissues is important for keeping the people who have them healthy. It will take a lot of vagina studies to overcome centuries of neglect, Gross writes. But the book provides a glimpse into what is possible when researchers (finally) pay attention. — Erin Garcia de Jesús

New Mexico ISEF finalists enjoy a break at ISEF 2018.



Karen Kinsman, MS, PMP
Director/Sr. Program Manager,
University of New Mexico
STEM-H Center; Co-director,
Central New Mexico STEM
Research Challenge

CELEBRATING OUR VOLUNTEERS

It's been nearly 20 years since I stepped into the world of precollege STEM research competition management. I have been a director for a fair affiliated with the Society for Science's International Science and Engineering Fair, spent several years directing the regional Science Olympiad and Junior Science and Humanities competitions in New Mexico, and seen the University of New Mexico STEM-H Center grow into what it is today. The center seeks to expand science, technology, engineering, math and health opportunities in New Mexico. It has been a long, challenging and very fulfilling journey.

There are two things that have risen and stayed at the top of my "gratitude pile" over the course of my career. First are the relationships built and nurtured. Second are the networks of people, both students and educators, that I have helped grow and develop. I have been told that connecting people is my superpower. But it's more than that: It's my passion all day, every day! Through ISEF and our regional competitions, I have facilitated connections that have resulted in mentorships, in the birth of creative

new partnerships, and in the identification of some truly wonderful career opportunities for our alumni.

My excitement for the future is interwoven with my many fond memories of volunteering at ISEF over the years, including providing support at registration or other elements of the fair. I recall all the students I've had the privilege to support and the amazing things they have already accomplished early in their careers and lives. I revel in our conversations, especially when they tell me all about what they're doing now. I recall all the tireless, selfless educators who gave everything they had to their students so they could be successful. It's a privilege to be able to form genuine connections with so many students and educators, and to support each of them on their journeys to amazing successes.

I may not be a scientist, engineer, mathematician or technical genius. But man, can I bring people together—and it's so exciting to build the strong networks that are powering the future of STEM innovation in New Mexico and beyond.

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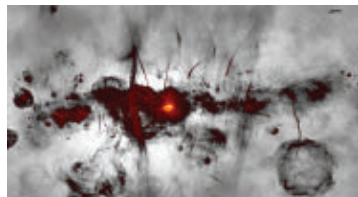


FEBRUARY 26, 2022

SOCIAL MEDIA

Cosmic gallery

The MeerKAT radio telescope array in South Africa provided a stunning new look at the Milky Way's chaotic center, as seen in radio wavelengths (shown below), **Lisa Grossman** reported in "The Milky Way's heart shines in radio waves" (SN: 2/26/22, p. 32). Reader **Andy Drews** marveled at the image on Facebook: "Hard to believe that it's not a piece of artwork."



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Going the distance

*An Arctic hare dubbed BBYY trekked at least 388 kilometers across the tundra in 49 days, shattering expectations for a creature that typically stays close to home, **Ariana Rimmel** reported in "An Arctic hare's journey across northern Canada breaks records" (SN: 2/26/22, p. 15).*

Reader **Sharon Davies** wanted to know why the Arctic hare traveled such a great distance.

Adult female hares from BBYY's population "might spend the summer in areas with few predators, but also little food, to protect their babies," says **Dominique Berteaux**, a mammalian ecologist at the Université du Québec à Rimouski in Canada. He and colleagues hypothesize that the record-breaking hare made the epic trip to spend the winter in a region where food was more abundant, but also where predators were plentiful.

In September, the team plans to put satellite collars on young hares to track them through winter and learn more about their travel habits. "We have a feeling that they don't follow their mother, but rather gather in large groups that travel together," **Berteaux** says.

Solar risks

*The most powerful telescope ever launched has reached its final destination in space, but it still has a long to-do list before it can start doing science, **Lisa Grossman** reported in "James Webb telescope gets in position" (SN: 2/26/22, p. 10).*

Reader **Elizabeth McDowell** wondered if the telescope is protected against solar storms.

During a solar storm, the sun spews radiation and charged particles, which could potentially damage the James Webb Space Telescope's electronics. While the telescope won't be able to maneuver away from such emissions, it has enough metal shielding to protect those components, says **Paul Geithner**, the deputy project manager for the telescope's technical side at NASA's Goddard Space Flight Center in Greenbelt, Md.

Solar storms could cause static charges to build up on the surfaces of

the telescope, **Geithner** says, leading to sudden discharges that can harm the electronics. To protect against this concern, all of the telescope's surfaces, including the five-layer sunshield, are grounded, he says.

Tagging along

*A recently found space rock shares Earth's orbit around the sun. This "Trojan asteroid" is only the second one discovered to belong to Earth and hangs out at the fourth Earth-sun Lagrange point, or L4, **Liz Kruesi** reported in "Earth Trojan asteroid has company" (SN: 2/26/22, p. 15).*

Reader **Peter Gaudio** pointed out that the James Webb Space Telescope is located at another Lagrange point, called L2. A Lagrange point is a region in space where the gravitational pull of two massive celestial bodies and the centrifugal force of a smaller object balance one another to create a stable location. The telescope requires propulsion periodically to stay in place. **Gaudio** asked why the Trojan asteroid needs no such position maintenance.

While Lagrange points are relatively stable regions in space, some are less stable than others. "L1, L2 and L3 are not precisely stable, so a spacecraft or asteroid would need only a small push to be knocked out of the area. That is why the telescope needs thrusters to stay in position at L2," **Kruesi** says. "The L4 and L5 points, though, are truly stable. They are huge regions where space rocks and dust can just chill."

I hate to burst your bubble

*Researchers created a bubble made with water, plastic microparticles and glycerol that lasted for 465 days before popping, **Emily Conover** reported in "'Everlasting' bubbles can linger for a long time" (SN: 2/26/22, p. 4).*

On Twitter, reader **@niloulsarvian** asked what the potential uses are for such a long-lasting bubble.

"Bubbles are the building block of foams," says physicist **Michael Baudoin** of the University of Lille in France. "This new material could be used for the development of ultrastable foams."



The depths of light pollution at sea

The first global atlas of ocean light pollution shows that large swaths of the sea are awash in the nighttime glare of artificial lights. From urbanized coastlines along the Persian Gulf to oil complexes in the North Sea (shown above), humans' glow is powerful enough to penetrate deep into many waters, potentially changing the behaviors of the creatures that live there.

Artificial light is known to affect land dwellers, such as by shrinking some insect populations or making it harder for sparrows to fight off West Nile virus (SN: 2/17/18, p. 12). But the bright lights of coastal cities, oil rigs and other offshore structures can also create a powerful glow in the sky over the sea.

To assess where in the ocean this glow might have the strongest impact, marine biogeochemist Tim Smyth of Plymouth Marine Laboratory in England and colleagues combined a 2016 world atlas of artificial night sky brightness with ocean and atmospheric data (SN: 7/9/16, p. 32). Those data include shipboard measurements of artificial light, monthly satellite data

from 1998 to 2017 to estimate the prevalence of light-scattering phytoplankton and sediment, and computer simulations of how different wavelengths of light move through the water. Regional and seasonal differences affect the depth to which light penetrates (shown above for a typical April).

Not all species are equally sensitive to artificial light, so to assess the potential impact of this glow on animals, the team focused on copepods, shrimplike creatures that are a key part of many ocean food webs. Like other zooplankton, copepods use the sun or the winter moon as a cue to plunge en masse to the dark deep, seeking safety from surface predators.

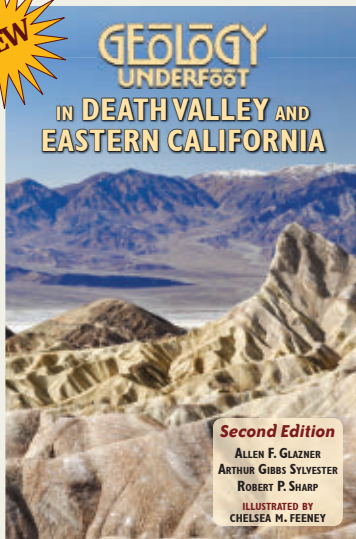
Humans' nighttime light has the most impact in the top meter of the water, the team reported December 13 in *Elementa: Science of the Anthropocene*. Here, artificial light is intense enough to cause a biological response, such as triggering copepods to dive, across nearly 2 million cumulative square kilometers of ocean, an area roughly that of Mexico. Twenty meters down, the total affected area shrinks by more than half. — Carolyn Gramling

Get out of your car and take a closer look at the landforms around you!

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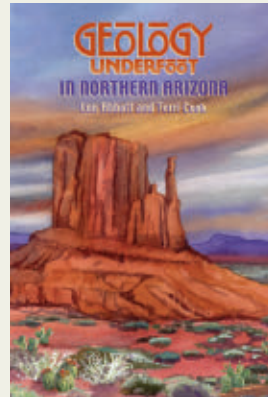
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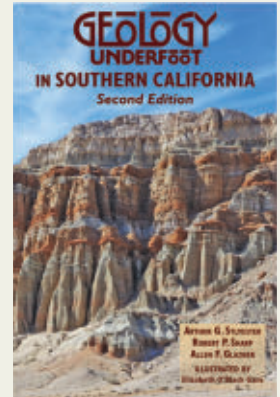


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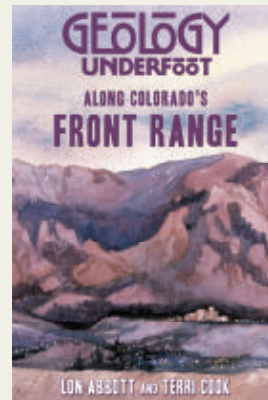
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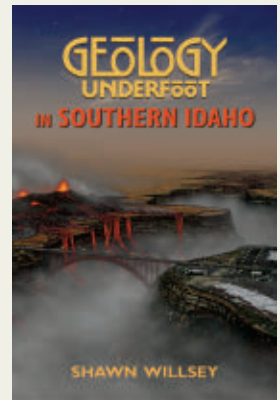
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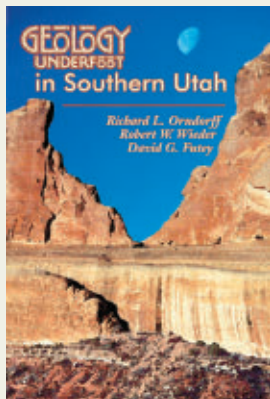
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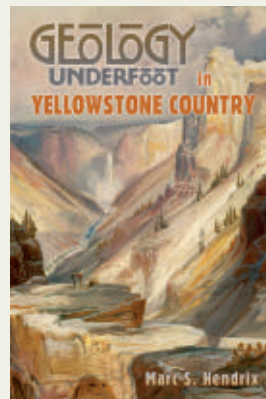
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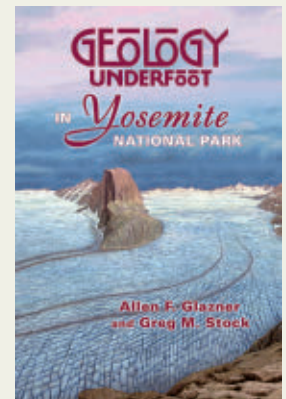
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